

Taking stock of evidence-based healthcare in the undergraduate medical curriculum at Stellenbosch University: Combining a review of curriculum documents and input from recent graduates

A Rohwer,¹ BCur, MScClinEpi; B Willems,² MB ChB; T Young,^{1,2} MB ChB, FCPHM, MMed

¹ Centre for Evidence-Based Health Care, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa

² Division of Community Health, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town, South Africa

Corresponding author: A Rohwer (arohwer@sun.ac.za)

Background. The Stellenbosch University Rural Medical Educational Partnership Initiative (SURMEPI) aims to increase the quality and retention of medical doctors, and regionally relevant research. Strengthening evidence-based healthcare (EBHC) knowledge and skills at an undergraduate level is important within this context.

Objectives. To assess and describe the current undergraduate medical EBHC curriculum in order to identify opportunities to enhance EBHC teaching, and to explore challenges related to EBHC experienced by recently graduated doctors.

Methods. We used methodological triangulation to assess current EBHC teaching and learning through a document review and a survey of recent graduates. We extracted learning outcomes from module guides that related to prespecified EBHC competencies. Our electronic survey collected quantitative data, which were analysed with SPSS, and qualitative data, which were coded with ATLAS.ti and grouped into emerging themes.

Results. EBHC teaching was fragmented and concentrated in the first and last phase of the medical curriculum. Most survey respondents agreed that it was important to learn EBHC at undergraduate level, and that there was a need for increased teaching of certain EBHC competencies. Recently graduated doctors identified lack of access to literature as the main challenge when practising EBHC. Other challenges included time constraints, work overload, lack of EBHC skills, lack of self-motivation, applicability of the evidence and the work environment.

Conclusion. Recent graduates felt that they needed more EBHC learning opportunities within the undergraduate medical curriculum. Existing EBHC teaching and learning for undergraduate medical students need to be enhanced by integrating EBHC into clinical modules and scaffolding it throughout all the phases of the curriculum.

Afr J Health Professions Educ 2015;7(1 Suppl 1):98-104. DOI:10.7196/AJHPE.501



South Africa (SA) faces a significant burden of: HIV/AIDS and tuberculosis (TB); chronic illness and mental health; injury and violence; and maternal, neonatal and child health. Because of the limited number of healthcare professionals, especially working in rural areas,^[1-4] there is

a need to enhance human and research capacity and to retain clinicians and researchers in these areas. Strengthening evidence-based healthcare (EBHC) competencies is particularly important to promote use of best care.^[5] Glasziou *et al.*^[6] recommend that EBHC becomes an integral part of learning in the curriculum of all healthcare professionals, since learning the fundamentals of research and the basic knowledge and skills of EBHC are essential for successful implementation of EBHC and subsequent improvement in quality of healthcare.

The Sicily statement on EBHC, which is a consensus statement from an international group of EBHC teachers and developers, advises that 'all health care professionals need to understand the principles of EBP (evidence-based practice), recognise it in action, implement evidence-based policies, and have a critical attitude to their own practice and to evidence'. It also puts forward that EBHC curricula should be based on the five steps of EBHC, namely: formulating clear questions based on knowledge gaps; searching the literature to find answers to the questions; critically appraising the literature for validity and reliability; applying the results to the unique healthcare setting; and auditing the process.^[7] The recent *Lancet* report on the health professional for the 21st century^[8] echoes this by proposing

that healthcare professional training should become transformative. Transformative learning aims to develop change agents – graduates with leadership attributes, who can function in a team within the local health systems. One of the fundamental shifts inherent in transformative learning is closely aligned to the steps of EBHC – the shift from memorisation of facts to 'critical reasoning that can guide the capacity to search, analyse, assess and synthesise information for decision-making'.^[8]

Although the design of EBHC curricula typically mirrors the five steps of EBHC as explained above, implementation of these curricula differs and is not standardised. Maggio *et al.*^[9] reviewed the literature on recent educational EBHC interventions for undergraduate medical students and recommend, *inter alia*, that undergraduate teaching of EBHC should start in the early clinical years and that it should be integrated throughout the entire curriculum, providing learners with multiple exposures to EBHC in different contexts, thus strengthening their EBHC knowledge, skills and confidence.

With the goal of enhancing EBHC teaching at Stellenbosch University (SU), we conducted a situational analysis of current EBHC teaching in the undergraduate medical curriculum (MB,ChB), which we based on the six-step approach to curriculum development advocated by Kern *et al.*,^[10] commencing with identifying the problem and doing a general needs assessment estimating the difference between the ideal and the current teaching approach. We made use of methodological triangulation: to assess and describe the content of and approach to EBHC teaching; to identify

potential gaps in the EBHC curriculum as well as opportunities to enhance EBHC teaching and learning (document review); to gather perspectives of recent graduates regarding the appropriateness of EBHC teaching (survey of recent graduates); and to assess the perspectives of lecturers involved in undergraduate teaching, on the extent to which EBHC competencies are integrated into the medical curriculum (interviews with lecturers).

This article reports the findings of the first two components of the situational analysis by addressing the overarching questions: Do medical graduates from SU have the necessary knowledge and skills to practise in an evidence-informed manner? What other challenges need to be addressed in order to encourage evidence-informed decision-making?

Methods

We developed key and enabling EBHC competencies, based on the CanMEDS framework^[11] and further informed through a review of national and international literature on EBHC teaching and learning^[7] to determine the ideal approach to teaching EBHC. We refined these competencies through discussion with local faculty members, as well as international experts in the field. The key competencies mirror the five steps of EBHC (asking questions, accessing the literature, critically appraising the literature, applying the results and auditing), while the enabling competencies encompass basic underlying knowledge like epidemiology and biostatistics, how to search medical databases and having a philosophy of critical enquiry (Fig. 1 provides a graphical representation of the EBHC competencies).^[12] At undergraduate level, students should be able to identify and acknowledge knowledge gaps, ask clear questions, access the literature, appraise and interpret the evidence, and know the approach to applying the evidence. Applying evidence in practice and auditing are part of the postgraduate competencies.

Structure of the SUMB,ChB programme

The MB,ChB programme runs over six calendar years, divided into three phases, and aims to 'produce graduated Stellenbosch doctors who have the knowledge, skills and attitudes to optimally utilise the opportunities available during the two-year internship so as to function autonomously in the primary health care sector thereafter, and who have acquired the ability

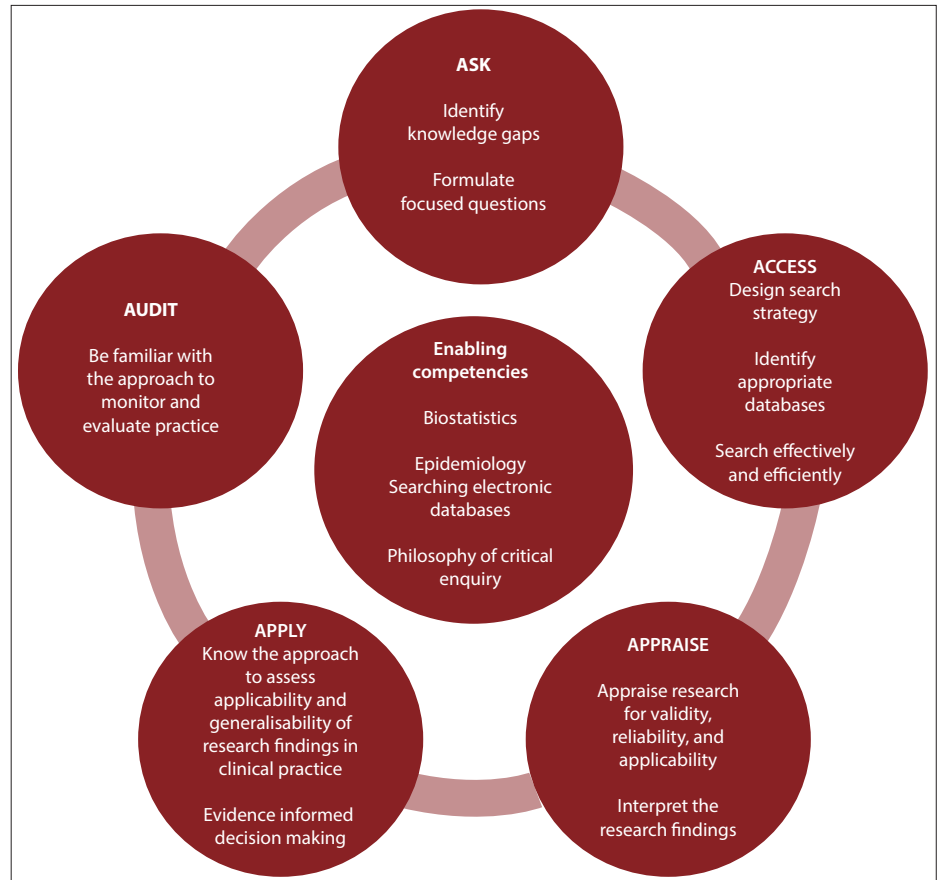


Fig. 1. Key and enabling EBHC competencies.

and insight to develop further personally and professionally'.^[13]

After the 6 years of training at the university, graduates have to complete 2 years of internship and 1 year of community service.

Document review

To assess and describe the current, formal content of and teaching approach to EBHC, we performed a document review of all the 2011 module guides relevant to the entire MB,ChB curriculum. These guides detail module objectives, outcomes and relevant course outlines. We used learning outcomes contained in the module guides as the unit of analyses and extracted any learning outcome that could be related to the pre-specified, undergraduate EBHC competencies (Fig. 1) with the help of a standardised, pre-piloted data extraction form.

We classified each learning outcome as knowledge, skill or attitude and assigned the corresponding level of cognitive functioning according to Bloom's taxonomy^[14] to all the 'knowledge' outcomes. One author (AR) was responsible for extracting the learning outcomes

relevant to EBHC, while two authors (AR, TY) analysed the extracted data and, for knowledge outcomes, made judgements of the corresponding level of cognitive functioning by matching the verbs contained in the learning outcome to those used for each level of Bloom's taxonomy^[15] (Table 1). Discrepancies were resolved through discussion. A detailed description and examples of our methods are described elsewhere.^[16]

Survey of recent graduates

We designed an electronic survey to assess the appropriateness of EBHC teaching and learning in the undergraduate medical curriculum. We invited recent graduates of the medical programme at SU to participate in the survey in 2011. We chose recent graduates (as opposed to current students) because they were able to tell us whether they were adequately equipped with the necessary knowledge and skills to practise in an evidence-informed manner. Likert-scale questions specifically assessed the extent to which pre-identified EBHC competencies were covered in the medical curriculum. Open-ended questions explored the opinions of graduates

Table 1. Bloom's levels of cognitive functioning and corresponding verbs

Bloom's level of cognitive functioning	Verbs describing the learning outcome
Knowledge	Define, describe, identify, know, label, list, match, name, outline, recall, recognise, reproduce, select or state
Comprehension	Comprehend, convert, defend, distinguish, estimate, explain, extend, generalise, give examples, infer, interpret, paraphrase, predict, rewrite, summarise, translate
Application	Apply, change, compute, demonstrate, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, solve, use
Analysis	Analyse, break down, compare, contrast, diagram, deconstruct, differentiate, discriminate, distinguish, identify, illustrate, infer, outline, relate, select, separate
Synthesis	Categorise, combine, compile, compose, create, devise, design, explain, generate, modify, organise, plan, rearrange, reconstruct, relate, reorganise, revise, rewrite, summarise, tell, write
Evaluation	Appraise, compare, conclude, contrast, criticise, critique, defend, describe, discriminate, evaluate, explain, interpret, justify, relate, summarise, support

regarding EBHC teaching and learning during their undergraduate studies as well as the challenges and facilitators of practising EBHC experienced in the working environment (Table 2).

The survey was set up using the internet-based SUN Surveys tool, managed and hosted by SU. Recent graduates' contact details acquired through the alumni office were therefore secure. With the help of the SU Alumni Office, we managed to obtain 842 email addresses of the 980 MB,ChB students who graduated between 2004 and 2010. An invitation to complete the survey was sent to all the email addresses. After a lower than expected response rate we obtained permission to add a financial incentive for participants completing the survey.

We analysed quantitative data using SPSS statistical software. Qualitative data were analysed and coded with the help of ATLAS.ti software. One author (AR) coded all the answers, while the second author (TY) coded 25% of the same data independently. Both authors agreed on more than 80% of the codes and we thus relied on the coding of the first author. We grouped codes into emerging themes for each question.

Ethics approval was obtained for the document review and the survey.

Results

Survey respondents

We received a total of 222 (26%) responses. The denominator for each answer was the number of participants who answered the specific question and not the total number of participants who participated in the survey.

A balanced response proportion was received from doctors who completed their degree in the years included in the study (Table 3). The most common responders graduated in 2005 (18.5%) followed by 2006 (17.4%) and 2010 (15.0%). Most of the participants were working as medical officers, i.e. independent medical practitioners working in a public hospital setting. The second largest group comprised registrars (young doctors currently specialising).

EBHC competencies in the medical curriculum

We found evidence of EBHC competencies in the medical curriculum, although they were fragmented and concentrated in phases I and III. Learning outcomes mostly focused on therapy questions. Fig. 2 illustrates the results of the document review plotted on the structure of the 6-year curriculum. The only two modules where students were required to go through the steps of EBHC to answer a clinical question were 'Health and disease in the community' (MB,ChB III) and 'Health, disease and disability in the community' (MB,ChB V).

Table 2. Open-ended questions contained in the survey

What other EBHC competencies would have helped you in improving patient care?
What, if any, EBHC component of the SU curriculum would you omit?
What, if any, EBHC component would you add to the SU curriculum?
What challenges in practising EBHC have you encountered since graduation?
What obstacles prevent you from resolving these challenges?
Do you have any recommendations to improve EBHC training at SU?

Table 3. Characteristics of survey respondents

Participant demographic details	n (%)	
Year graduated (MB,ChB)	2004	31 (10.8)
	2005	53 (18.5)
	2006	50 (17.4)
	2007	31 (10.8)
	2008	39 (13.6)
	2009	40 (13.9)
	2010	43 (15.0)
Current position	Internship	41 (14.2)
	Community service	39 (13.5)
	General practitioner	38 (13.2)
	Medical officer	82 (28.5)
	Registrar	70 (24.3)
	Specialist	3 (1.0)
	Other medical	6 (2.1)
Other outside medical	2 (0.7)	
Unemployed	7 (2.4)	

The quantitative results of the survey echoed the findings of the document review. Most respondents (221/222; 99.5%) agreed that it was important to learn EBHC at undergraduate level. Most doctors (192/222; 86%) were also of the opinion that EBHC teaching at SU was adequate to prepare them for

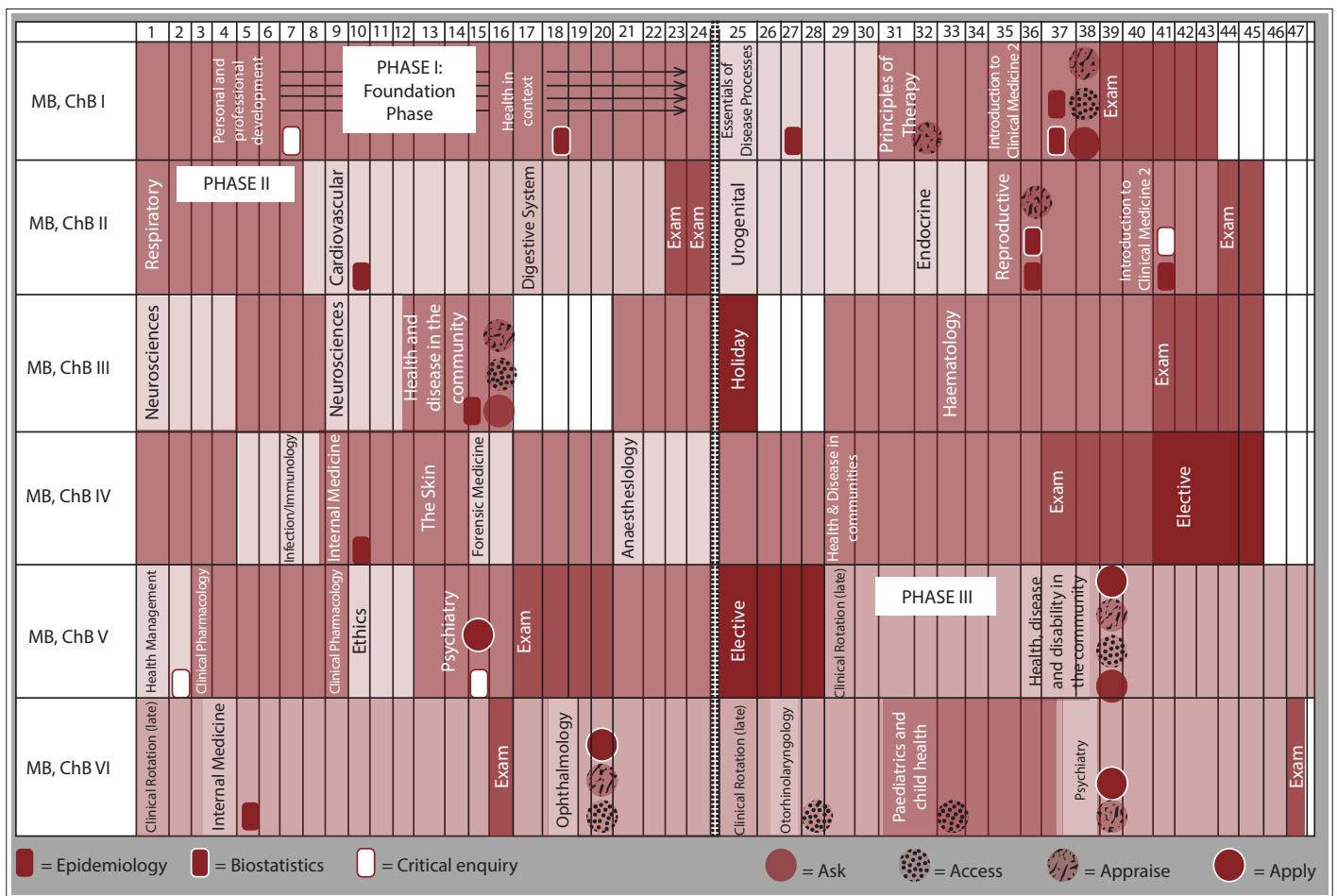


Fig. 2. Summary of EBHC competencies throughout the MB,ChB curriculum at SU.

practising EBHC in the SA health system. Only 27/222 (12.2%) disagreed on this question and 3/222 (1.4%) disagreed quite strongly. Regarding the various EBHC competencies, most stated that EBHC competencies were covered to a basic or adequate extent and few indicated they were covered comprehensively.

When analysing the qualitative data, it emerged that there was a need for increased teaching of certain EBHC competencies, especially related to searching databases, critically appraising studies and interpreting results; this appeared to contradict the findings of the quantitative data. Survey participants also felt that EBHC teaching in the medical curriculum was confined to the Family Medicine rotation and that this was inadequate. They highlighted the need for repeated teaching of EBHC by making use of relevant examples in different disciplines, therefore integrating EBHC teaching across the curriculum. Recent graduates recommended that there should be more emphasis on EBHC in undergraduate medical training, but that it should also be made more interesting and relevant. Applying the principles of EBHC in a hands-on manner (e.g. searching-the-literature workshops), as well as using interactive teaching methods, online learning platforms and social media, was recommended. Table 4 presents a summary of EBHC teaching within the MB,ChB curriculum, based on the combined results of the document review and the survey.

Challenges in practising EBHC in the clinical field

Recent graduates identified many challenges when practising EBHC. What stood out above all other challenges was the limited access to literature once

students graduate and no longer have access to SU library's databases. This considerably limits accessibility of journal articles, making it very difficult to practise EBHC.

'No free access to IT technology in work environment. Financial constraints. Subscriptions to internet resources for medical professionals who are not affiliated with a university is extremely expensive.'

Another recurring challenge was time constraints and work overload.

'There is an enormous amount of data and studies on the internet – it's a challenge to choose only relevant studies and to interpret the results. This is time consuming and frustrating.'

'Too few hours in a day to work full time, CPD, a balanced life and to do literature searches for all the changing fields in medicine on top of that.'

Other challenges were related to the lack of EBHC skills, lack of self-motivation, application of evidence in practice (dealing with conflicting evidence; lack of relevant evidence; half-life of evidence; information overload), and the work environment (lack of exposure to EBHC and role models; costs of treatment; rigid hospital protocols and administration; resource constraints).

'We often do not have the resources to treat patients according to EBHC.'

'There is so much conflicting evidence out there, that's why I often find I practise according to my supervisors' advice, rather than EBHC.'
'Senior colleagues sometimes lack EBHC decision making and resort to that

Table 4. Summary of EBHC competencies covered in MB,ChB curriculum

EBHC competencies		Enabling competencies	Ask	Access	Appraise	Apply
Learning outcomes present in module outlines of the 6-year MB,ChB curriculum (document review)	Phase I (6 modules)	3 modules: Personal and Professional Development, Health in Context, Essentials of Disease Processes			1 module: Principles of therapy	
	Phase II (35 modules)	8 modules: Introduction to Clinical Medicine (1), Reproductive System, Introduction to Clinical Medicine (2), Cardiovascular System, Health and Disease in the Community, Internal Medicine, Psychiatry, Health Management	2 modules: Introduction to Clinical Medicine (1), Health and Disease in the Community	2 modules: Introduction to Clinical Medicine (1), Health and Disease in the Community	3 modules: Introduction to Clinical Medicine (1), Reproductive System, Health and Disease in the community	1 module: Psychiatry
	Phase III (11 modules)	1 module: Internal Medicine	1 module: Health, Disease and Disability in the Community	4 modules: Health, Disease and Disability in the Community, Ophthalmology, Otorhinolaryngology, Paediatrics and Child Health	3 modules: Health, Disease and Disability in the Community, Ophthalmology, Psychiatry	3 modules: Health, Disease and Disability in the Community, Ophthalmology, Psychiatry
	Highest level of cognitive functioning	Application	Application	Application	Evaluation	Application
Students' perception of coverage of EBHC competencies	Not at all, <i>n</i> (%)	Not addressed in survey	16 (7.2)	3 (1.4)	1 (0.5)	2 (0.9)
	Inadequate, <i>n</i> (%)	Not addressed in survey	40 (18.1)	35 (15.8)	36 (16.3)	28 (12.7)
	Basic, <i>n</i> (%)	Not addressed in survey	87 (39.4)	67 (30.3)	76 (34.4)	76 (34.4)
	Adequate, <i>n</i> (%)	Not addressed in survey	68 (30.8)	91 (41.2)	90 (40.7)	96 (43.4)
	Comprehensive, <i>n</i> (%)	Not addressed in survey	10 (4.5)	25 (11.3)	18 (8.1)	19 (8.6)
Students' responses to open-ended questions regarding EBHC teaching (selected quotations)	What other EBHC competencies would have helped you in improving patient care?	EBHC skills	<ul style="list-style-type: none"> • 'Better basic and practical knowledge about statistics and study types, and the implication thereof' • 'Better teaching on making use of available databases for evidence' • 'Evaluating a study, was maybe too basic – it was a difficult topic to understand – maybe more time should be spent on it' 			
	What competencies would you omit or add to the medical curriculum at SU?	Approach to teaching EBHC	<ul style="list-style-type: none"> • 'The EBHC should, instead of being only separate teaching modules, be incorporated into the general curriculum' • 'I would move EBHC to early in the curriculum as it would be formative in our thinking about the critical appraisal of all information during the rest of our studies' • 'This part of the SU programme failed because it was confined to one discipline: Family Medicine. Its relevance and importance with regard to other disciplines were not emphasised' • 'EBHC should be part of every block of teaching' 			

which is known to them and what they feel comfortable with, which is often outdated. They expect you to do things in the same way, or if you do it differently (but according to EBHC guidelines) they believe you're wrong.'

Discussion

The situational analysis of EBHC teaching at SU aimed to evaluate current EBHC teaching and to identify gaps and opportunities to enhance teaching. We used triangulation of methods as a means of comparing data from different sources on the same topic. By means of cross-checking different sources it is possible to increase validity of the findings.^[17] While the document review gave us a good overview of the structure of the medical curriculum and provided us with baseline information on the current approach to EBHC teaching, the online survey of recent graduates gave us an opportunity to gain insight into graduates' perspectives of EBHC teaching, their experiences thereof and challenges they face in clinical practice. A combination of quantitative and qualitative data enhanced the richness of data collected. We present the results of the document review and the graduate survey in this article. The interviews with lecturers are currently being analysed.

The document review, based on the 2011 module guides, shows that there was fragmented teaching of enabling and key EBHC competencies in the curriculum. Although these competencies were not always clearly formulated in the learning outcomes, we found that enabling competencies were mostly addressed in phase I and key competencies in phases II and III (Fig. 2). Based on the module guides, there was no evidence of EBHC teaching in most theoretical and clinical modules of phase II, which runs over more than half of the curriculum. Only two EBHC tasks required students to go through the whole EBHC process. Both these tasks were within the Family Medicine, Community Health and Rehabilitation clinical rotations, one in the early clinical phase and one in the late clinical phase, and focused on questions about treatment. There seemed to be progression from lower to higher level cognitive functioning according to Bloom's taxonomy from the first to the sixth year of the MB,ChB programme.

Survey respondents emphasised the lack of knowledge of biostatistics, epidemiology and critical appraisal as well as the lack of effective searching skills. SU graduates recommended that EBHC teaching should become an essential part of the curriculum, starting with an introduction to concepts in the early phase and reinforcing concepts throughout the curriculum by integrating EBHC teaching into all disciplines and not confining it to Family Medicine within the Health and Disease in Communities modules. Ideally, there should be integrated teaching of EBHC throughout the theoretical and clinical modules so that the MB,ChB graduates are proficient in incorporating best evidence in the decision-making process including questions related to risk factors, diagnosis, prevention, treatment and prognosis. They also recommended that EBHC teaching should become more interactive and that online learning platforms and social media could be used more effectively to facilitate learning. This resonates with international literature regarding teaching of EBHC. Kahn and Coomarasamy^[18] have proposed a hierarchy of effective teaching of EBHC, where interactive and integrated teaching of EBHC is seen as the most effective way of teaching and learning EBHC. A recent overview of systematic reviews^[19] that included 16 systematic reviews examining the effects of educational activities on EBHC, found that when comparing single interventions (a workshop, journal club, lecture or e-learning) with multifaceted interventions (a combination of different strategies, e.g. lectures, tutorials, e-learning, journal clubs, etc.), multifaceted clinically integrated educational activities were more likely to increase EBHC knowledge, skills, attitude and behaviour.

Recent graduates also reported on the challenges of practising EBHC. Inadequate access to the medical literature was one of the biggest barriers to practising EBHC. Under- and postgraduate medical students have free access to certain electronic databases (e.g. The Cochrane Library) and journals through SU's institutional subscription. After graduation, they no longer have free access to important articles. Private subscriptions are expensive and individual articles can cost up to USD30 per article – prices that no young doctor is willing to pay. In recent years, there has been an increase in the number of scientific articles that are freely available on the internet. But the proportion of these open-access articles is still quite low and was estimated to be 20.4% by Björk *et al.* in 2009.^[20]

Even though time constraints, workload and access to electronic databases were predominantly mentioned, other relevant challenges included lack of EBHC skills to find and interpret relevant articles. More effective teaching of EBHC at undergraduate level can address the lack of EBHC knowledge and skills. If medical students are competent in EBHC once they graduate, they will not only have more knowledge and skills, but will also be able to overcome some of the other barriers encountered by respondents. As an example, searching online databases for relevant articles is less time-consuming if one has adequate skills and practice.

Reported challenges that are more difficult to address include: the resistance to change of senior colleagues; the lack of role models in clinical practice; lack of resources; and the hierarchical structure, as well as the policies in healthcare institutions. It is very hard to influence these external factors that impact on practising EBHC and this goes well beyond the medical training of undergraduate students. A recent systematic review looking at the barriers to the use of evidence-based medicine by general practitioners, reported similar challenges to what we found in the survey.^[21] They also argue that practising EBHC in the clinical field is subject to a multitude of factors, much of which goes beyond education and training of EBHC. Nonetheless, sound training of EBHC at an undergraduate level would lay the foundation for successful implementation thereof and would ideally automatically become a part of the healthcare decision-making process.

One of the limitations of the document review is that assessment of EBHC competencies, as well as the alignment of the assessment to the learning outcomes could not be evaluated comprehensively. This is an important part of EBHC learning and was addressed in the interviews with the lecturers, currently being analysed. Furthermore, we did not address effective communication as a competency. This is an important part of evidence-based decision-making, since the patient preferences and values should also be taken into account when making informed decisions about healthcare interventions.^[22]

When considering the survey respondents, one could argue that recent graduates feeling either exceptionally positive or negative about the way EBHC was taught were more likely to participate in the survey. The response rate could have been higher, but compares well with other studies of a similar type. In addition, we received a balanced response proportion from doctors who completed their degrees in the years included in the study, and from various job positions, representing recently graduated doctors in South Africa.

Conclusion

Recent graduates felt that they needed more EBHC learning opportunities within the undergraduate medical curriculum. The results of our situational analysis show that existing EBHC teaching and learning for undergraduate medical students needs to be enhanced. This can be done by integrating EBHC

into a variety of disciplines, and scaffolding it throughout the curriculum thereby equipping graduates with the necessary EBHC knowledge, attitude and skills to make well-informed healthcare decisions in their daily practice.

Authors' contributions. Anke Rohwer (AR) and Taryn Young (TY) developed the methodology for the document review of the medical curriculum, with input from the SURMEPI curriculum review working group for the medical curriculum: Ms Anke Rohwer, Dr Taryn Young, Prof Lilian Dudley, Dr Fidele Mukinda, Dr Neil Cameron, Dr Bart Willems, Prof Shaheen Mehtar, Dr Frederick Marais, Dr Angela Dramowski, Prof Ben van Heerden. AR and TY analysed data and interpreted the findings. Bart Willems (BW) developed the methodology for the survey of recent graduates, with input from the SURMEPI curriculum review group as listed above. BW analysed the quantitative data; AR and TY analysed the qualitative data and interpreted the findings. AR drafted the manuscript. TY and BW critically engaged with the content and provided input. All authors have approved of the final version of this manuscript.

Acknowledgements. This research has been supported in part by the US President's Emergency Plan for AIDS relief (PEPFAR) through HRSA under the terms of T84HA21652 and via SURMEPI. This work is based on the research supported in part by the National Research Foundation of South Africa (Unique Grant No. 86420).

Ethical approval. The document review of the medical curriculum (N11/07/205) and the survey of recent graduates (S11/10/004) were approved by the Stellenbosch University Ethics Committee of the Faculty of Medicine and Health Sciences.

References

- Dussault G, Franceschini MC. Not enough there, too many here: Understanding geographical imbalances in the distribution of the health workforce. *Hum Resour Health* 2006;4:12. [http://dx.doi.org/10.1186/1478-4491-4-12]

- Department of Health: Republic of South Africa. A National Human Resources Plan for Health Pretoria: DoH, 2006.
- Greysen SR, Dovlo D, Olapade-Olaopa EO, Jacobs M, Sewankambo N, Mullan F. Medical education in sub-Saharan Africa: A literature review. *Med Educ* 2011;45(10):973-986. [http://dx.doi.org/10.1111/j.1365-2923.2011.04039.x]
- Mayosi BM, Lawn JE, van Niekerk A, Bradshaw D, Abdoel Karim SS, Coovadia HM. Health in South Africa: Changes and challenges since 2009. *Lancet* 2012;380(9858):2029-2043. [http://dx.doi.org/10.1016/s0140-6736(12)61814-5]
- Chinnock P, Siegfried N, Clarke M. Is evidence-based medicine relevant to the developing world? *PLoS Med* 2005;2(5):e107. [http://dx.doi.org/10.1371/journal.pmed.0020107.g001]
- Glasziou P, Burls A, Gilbert R. Evidence-based medicine and the medical curriculum: The search engine is now as essential as the stethoscope. *BMJ* 2008;337:704-705. [http://dx.doi.org/10.1136/bmj.a1302]
- Dawes M, Summerskill W, Glasziou P, et al. Sicily statement on evidence-based practice. *BMC Med Educ* 2005;5(1):1. [http://dx.doi.org/10.1186/1472-6920-5-1]
- Frenk J, Chen L, Bhutta Z, et al. Health professionals for a new century: Transforming education to strengthen health systems in an interdependent world. *Lancet* 2010;376:1923-1958. [http://dx.doi.org/10.1016/S0140-6736(10)61854-5]
- Maggio LA, Tannery NH, Chen HC, ten Cate O, O'Brien B. Evidence-based medicine training in undergraduate medical education: A review and critique of the literature published 2006-2011. *Acad Med* 2013;88:1022-1028. [http://dx.doi.org/10.1097/ACM.0b013e3182951959]
- Kern DE, Thomas PA, Howard DM, Bass BE. *Curriculum Development for Medical Education. A Six-Step Approach.* Baltimore: John Hopkins University Press, 1998.
- Frank J. *The CanMEDS 2005 Physician Competency Framework. Better Standards. Better Physicians. Better Care.* Ottawa: The Royal College of Physicians and Surgeons of Canada, 2005.
- Rohwer A, Young T, van Schalkwyk S. Effective or just practical? An evaluation of an online postgraduate module on evidence-based medicine (EBM). *BMC Med Educ* 2013;13:77. [http://dx.doi.org/10.1186/1472-6920-13-77]
- http://sun.ac.za/english/faculty/healthsciences/students/prospective-students/programmes (accessed 11 July 2011).
- Bloom BS, Engelhart MD, Furst EJ, Hull WH, Krathwohl DR. *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook 1: Cognitive Domain.* New York: David McKay; 1956.
- Bloom's Taxonomy: The three types of learning. <http://www.nova.edu/hpd/testing/ctl/forms/bloomstaxonomy.pdf> (accessed 5 July 2011).
- Rohwer A, Schoonees A, Young T. Methods used and lessons learnt in conducting document reviews of medical and allied health curricula: A key step in curriculum evaluation. *BMC Med Educ* 2014;14(1):236. [http://dx.doi.org/10.1186/1472-6920-14-236]
- Coleman M, Briggs ARJ. *Research Methods in Educational Leadership and Management.* Thousand Oaks, CA: Sage, 2002.
- Khan KS, Coomarasamy A. A hierarchy of effective teaching and learning to acquire competence in evidence-based medicine. *BMC Med Educ* 2006;6:59. [http://dx.doi.org/10.1186/1472-6920-6-59]
- Young T, Rohwer A, Volmink J, Clarke M. What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. *PLoS One* 2014;9(1):e86706. [http://dx.doi.org/10.1371/journal.pone.0086706]
- Björk BC, Welling P, Laakso M, Majlender P, Hedlund T, Guðnason G. Open access to the scientific journal literature: Situation 2009. *PLoS one* 2010;5(6):e11273. [http://dx.doi.org/10.1371/journal.pone.0011273]
- Zwolsman S, te Pas E, Hooft L, Wieringa-de Waard M, van Dijk N. Barriers to GPs' use of evidence-based medicine: A systematic review. *Br J Gen Pract* 2012;62(600):e511-521. [http://dx.doi.org/10.3399/bjgp12X652382]
- Sackett DL, Rosenberg WM, Gray JAM, Haynes RB, Richardson WS. Evidence-based medicine: What it is and what it isn't. *BMJ* 1996;312:71.