Evidence-Based Medicine (EBM) is heralded as a new paradigm of medicine. Is it? What is its link to epidemiology? Does an evidence-based (EB) approach apply also to other health sciences and to public health in particular? What has epidemiology already achieved in these domains, and what remains to be done? What should our priorities be in the coming years? The EB approach is essential in all health sciences at two levels: for problem solving, and for decision making. It applies to all health sciences, be it medicine, nursing, public health, or others.

Many epidemiological principles, methods and techniques are put into good use in EBM. The EB “movement” is attractive in its use of clearly defined procedures, generalizing (not always explicitly) the application of good epidemiologic principles, methods, and techniques. Epidemiology must now contribute to the evaluation of the practice of an EB approach.

If one does not have access to a good medical library nor information technology does the EBM paradigm still hold? Hence, clinical and public health guidelines will benefit first from the EBM approach, then daily practice of EBM will follow, conditions permitting.

In public health, the challenges of the EB practice are not equally spread across health protection, different levels of disease prevention, and health promotion. The latter represents the most challenging task for epidemiology at any step of EB approach. Epidemiology, if successful in this domain, may help to build an EB health promotion. An Evidence-Based Public Health paradigm may be considered.

Epidemiology progresses by quantum leaps. As soon as it looks like it needs more energy, more oxygen, more ways and ideas where to go, important trends and endeavors appear. Only during our generation did epidemiology evolve from a mostly observational science into an integral part of health and disease oriented interventions. Almost simultaneously, it became a part of the core of reasoning in health sciences and an inseparable part of decision making in health policies, planning, and evaluation.

A new phenomenon, about five years “young”, “Evidence-Based Medicine” (EBM) is becoming to have an increasing influence on several health sciences and is likely to overshadow epidemiology in many minds.

Evidence-based medicine, evidence-based public health, systematic reviews, role of epidemiology

Views and opinions about EBM still vary between extremes. For example, the same recent introductory article about EBM elicited following Letters to the Editor:

"The article... could be the most important relevant scientific article I have ever read in my life..."

"... Quite frankly, this is the most specious and useless piece of garbage that I have encountered since I graduated from dental school."

As it happens often, the truth is somewhere in between as we may see it across the literature.

The other purpose of this paper is to highlight also the fact that there is no evidence-based health science without epidemiology and that epidemiology will continue to play a vital role...
in its further development. On the other hand, EBM is a unique opportunity for further expansion and development of epidemiology.

Three issues are worth addressing: Evidence-based medicine itself, the present and the future of the evidence-based approach in other health sciences like public health, and the role of epidemiology in this field.

**EVIDENCE-BASED MEDICINE, ITS RECENT EVOLUTION AND TRENDS**

EBM is a brainchild of Canadian clinical epidemiologists at McMaster University. It quickly attracted other protagonists from other parts of the North American continent and at the Oxford University in Europe among others.

The term itself was coined by Guyatt 4 in 1992 and defined later 5 as "...the process of systematically finding, appraising, and using contemporaneous research findings as the basis for clinical decisions" or 6 as "...the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients."

For Feussner 7 it represents ... the transition from "doing what seems the best ... to ...knowing what is the best".

The practice of EBM consists of several steps (modified and expanded):

* formulation of a clear clinical question from a patient's problem which has to be answered 5, 8, 9;
* searching the literature 5, 8, 9 for relevant articles and for other sources of information;
* critical appraisal (evaluation) of the evidence 5, 8, 9 (information provided by original research or by research synthesis, i.e. meta-analysis);
* selection of the best evidence (or useful findings) for clinical decision;
* linking evidence with clinical experience, knowledge, and practice 9;
* implementation of useful findings in clinical practice 9;
* evaluation of the implementation and the overall performance of the EBM practitioner 5, 8, 9;
* teaching others how to practice EBM 5.

These concepts and principles were brought to a large professional readership by a well orchestrated "publication spree" by the main EBM authors with more general introductory articles 5, 8, 9 and with an excellent ensemble of papers 10-24, applying the EBM principles and methods to various steps of clinical work, questions, and decisions be it risk, treatment, prognosis, decision analysis, etc.

The evidence is weighted from three angles:

* its validity per se,
* its importance, and
* its applicability to patients of particular interest.

Since then, EBM principles have been anchored in two books, Sackett’s et al 25 focusing on basic principles and methods, and Dixon et al 26 covering an evidence assessment. Two new journals have been launched, the Evidence Based Medicine 27, and the ACP Journal Club (American College of Physicians’ Journal Club). The evidence-based approach was further expanded into other fields, such as community medicine and health care 28, 29 and various clinical specialties: psychiatry 30, psychosomatic medicine 30 obstetrics and gynecology 30, nephrology 30, clinical biochemistry 30, diagnostic radiology 30, coronary care 30, pediatrics 30, inpatient general medicine 30, family medicine 30, to name just a few of their growing number.

As for specific problems and actions under EBM scrutiny, their range varies from banal and frequent such as upper respiratory infections 40 or otitis media 40 to post-myocardial management 40, percutaneous coronary revascularization 40, or to more general public health strategies like breast cancer screening 41-46 or cholesterol lowering diets 47, among others. Such important general strategies in the secondary and primary prevention of disease are more and more evidence-based.

A need for teaching programs in EBM 48-50 and systematic reviews 50 is increasingly felt, even in developing countries 50.

**EVIDENCE-BASED MEDICINE AS A NEW PARADIGM OF MEDICINE**

A new paradigm, or "view how we look at things" should change the previous one completely 51-56.

However, the EBM paradigm appears more evolution- ary than revolutionary. Here is why:

Medicine was always looking for a solid evidence, but it was always done in the framework of period thinking. When experience and faith only were available, the evidence was sought on that basis. Later, microbial and other agents served as "evidence", and an explanation of the underlying pathophysiologi- cal mechanisms of disease were considered as "evidence". With the advent of epidemiology, and probabilistic and relativistic thinking in medicine, the "evidence" is based on epidemiological premises of valid occurrence, observational analytical or experimental studies (trials). Without epidemiologi- cal methodological and practical experience in observational and experimental research it would be impossible today to gauge the evidence.

The grounds of meta-analysis in medicine 50, 56 have since expanded into the world of systematic reviews, particularly in the framework of the Cochrane Collaboration 57-60. Results of systematic reviews are introduced now into the work steps of the EBM as quoted above.

Hence, EBM is putting to a good and structured use the evidence from research and practice.

The novelty and range of the EBM should be also judged in comparison to several older paradigms which changed our
thinking in epidemiology and medicine. Let us quote just a few:

* transition from the deterministic paradigm of medicine into the probabilistic one and into the medicine of uncertainty;
* shift from the inductive to deductive research in epidemiology and medicine;
* dissociation of individual and disease in the community in the assessment of research results relevance and uses;
* development of cliniometrics introduction of soft data into epidemiological research;
* inroads into the study of in epidemiology less traditional endogenous factors in terms of genetic and molecular epidemiology;
* increasing attention to a dissociation of prognostic characteristics (factors and workers) from the risk ones;
* and also, the Evidence-Based Medicine.

We may successfully assume, that the deterministic -> probabilistic shift of medicine remains for the moment the most important paradigm of all the above.

Not every physician in the world can afford full electronic access to the global information system, yet. For the moment, let us think what is peculiar to the EBM paradigm, going beyond simple availability of computer technology. Let us be clear that the rapid access to the best information available is fundamental to the progress of medicine and public health today. On the other hand, basing a paradigm mostly on one single tool (computer technology) and having a busy clinician in mind might not be necessarily the greatest intellectual achievement around.

The old fashioned thought and data base called "book" is still around and doing very well. Not all books are evidence-based, some are. It depends on how much information in books is evidence-based. One book may be superb, another not. As a matter of fact, evidence-based databases like the Cochrane Library are a sort of evidence-based electronic books.

And if the information access is put aside, what is left from many "new" paradigms? Perhaps, we should always consider separately "paradigms of means" and "paradigms of the nature of things". All epidemiology textbooks call for the best evidence. This is not new. Beyond that, a balance between a paradigm of "thought" and a paradigm "how to do it and how to put it in the widest possible daily practice" is always highly desirable.

**IS THERE A WEAK LINK IN THE CHAIN OF EBM STEPS?**

Authors of EBM stress that EBM is "about integrating individual clinical expertise and the best external evidence" (and patient’s choice). Probably the most difficult step of EBM is to link the evidence with clinical knowledge and experience. Such a procedure remains for the moment a black box. What clinical knowledge and experience is relevant? Which criteria to allow experience and evidence to be combined? Which criteria allow one to supersede the other? How should each be weighted? Is there any flow chart organizing, in time and space, the steps combining evidence and experience? Does EBM aspire to become a “filter” of medical universe (Figure 1)?

The second potentially weak link is our high expectations from the teaching of EBM to others. Novices and the very large professional audience are much more able to find the evidence, than to assess its quality and relevance. Will every physician, nurse, dental surgeon or physiotherapist be able to learn it and to put the good evidence into practice?

These questions should be answered in a not so distant future.

**IS EBM SUFFICIENT IN ALL CASES AND SITUATIONS?**

Both authors of EBM and their critics recognize that it is not. It does not free the user from the necessity of understanding the underlying biology of the disease and to use this understanding as well as the evidence in clinical decision making. According to Marshall and Girotti, a knowledge of pathobiology supports a complementary approach, which they call an "inference-based medicine", i.e. the use of insights from studies in basic biology to establish principles that guide the practitioner’s approach to groups of patients. They illustrate such an approach in critical care surgery.
OTHER CRITIQUES OF THE EBM

Certain criticisms and limitations of EBM are valid and must be acknowledged. They are, among others:

* incomplete or contradictory evidence;
* increasing uncertainty when multiple technologies are combined into clinical strategies;
* it does not replace experience, analogy, and extrapolation of clinical reasoning;
* the incorporation of scientific evidence into a compassionate human setting is a challenge;
* relative separation of EBM from patient’s preferences and social ethic;
* the extrapolation of evidence based on groups from a clinical trial to a particular individual patient is a challenge;
* reviews of evidence may be quickly become outdated;
* EBM is impractical or impossible in many instances of emergency medicine;
* the evidence doesn’t exist in many instances;
* the effectiveness and efficiency of EBM practice is not yet evaluated and known (yes, EBM is very young, and there is no randomized clinical trial of the EBM practice, yet);
* it is difficult to practice EBM if the physician follows patient’s preferences (i.e. there is not always enough evidence for what the patient prefers);
* force feeding of physicians with EBM may antagonize many (EBM needs time and still a lot of fine tuning);
* not all health professionals will learn and practice EBM properly.

There has been an enormous effort to develop, launch, practice, and teach EBM. It must prove itself with time. It must also prove itself in various settings, specialties, in different medical cultures and traditions. It must show that it works, and that it is effective and advantageous in terms of cost-benefit ratio. Last but not least, it must be shown that patients ultimately benefit from its practice. It may sometimes be a bumpy road.

EVIDENCE-BASED APPROACH IN OTHER HEALTH SCIENCES

It is only logical that the evidence-based approach expands into characters. Newman, Dodson, Raphael and Marbach stress the applicability and relevance of the evidence-based approach in their medical domain.

Its applicability appears direct. Ways to teach undergraduates and already practicing dental surgeons have been also outlined.

Recently like here also embraced the evidence-based care. The evidence-based care in nursing will be probably more challenging. Nursing science works, like psychiatry, with a considerable amount of soft data, although the interpretation is more difficult to get, despite efforts aimed at are defining data methods in order to attempt quantification thereafter. Team and interdisciplinary work in nursing may not always lead to a straightforward evidence. Results, however, should be equally beneficial in this domain.

EVIDENCE-BASED PUBLIC HEALTH

Similarly to medicine, evidence-based public health (EBPH) might be seen as “…the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of communities and populations in the domain of health protection, disease prevention, health maintenance and improvement (health promotion)”. In the same spirit, it is “…the process of systematically finding, appraising, and using contemporaneous research findings as the basis for decisions in public health”.

As in evidence-based medicine, its steps should be:

* formulation of a clear question from a public health problem;
* searching for evidence;
* appraisal of evidence;
* selection of the best evidence for a public health decision;
* linking evidence with public health experience, knowledge, and practice;
* implementation of useful evidences in public health practice (policies and programs);
* evaluation of such implementations and of the overall performance of the evidence-based public health practitioner, and
* teaching others how to practice evidence-based public health.

Historically, public health has been always more evidence-based than other health sciences, particularly in the domain of health protection and disease prevention. Evidence of the etiological role of noxious agents and their controllability must be available, before an intervention and control is considered. Overall value of screening must be known, as well as protective efficacy and effectiveness before the launch of any control or eradication program.

One of the greatest challenges of the evidence-based approach appears in the domain of health promotion. Difficulties stem from the inherent characteristics of health promotion in contrast with disease prevention. It is the process of enabling individuals and communities to increase control over the determinants of health and thereby to improve their health. Its main objective is more encompassing, i.e. to maintain and improve health of individuals and communities. To measure and evaluate such dependent and independent variables is much more difficult than in the domain of disease prevention, where one or more determining factors are related usually to one particular health problem only. Waiting for
results is usually very long by disease prevention standards. Implementing health promotion measures is also more complex and often less feasible. Despite all this, evidence-based health promotion will require evidences as solid as in other domains of public health.

Perhaps, more evidence exists in the domain of health programs. Health policies, as laws, regulations, rules and understandings that are adopted on a collective basis to guide individual and collective health behavior are often more effective, but more difficult to evaluate (lack of valid concurrent control groups, etc.). Overriding political considerations in the choice and implementation of health programs and policies, as well as their frequent complexity do not facilitate the evidence-based approach either.

Chalmers et al. stress the scarcity of good evidence in terms of randomized controlled trials of public health interventions in Canadian public health literature as well as the need for reinforcement of the amount and quality of evidence in public health.

Public health programs are by nature more complex than clinical interventions. Funding, access to information, implementation, diversity and complexity of interventions, community participation, and measurement of outcomes are more difficult in many instances. Hayward and colleagues are worth quoting:

"... Defining and measuring the function of public health in society requires us to consider more than evaluation research. Protecting, counseling, educating, supporting and caring interventions can be justified by arguments that move beyond the right to effective care, toward the obligation to provide care and protection and enhance autonomy. It is also a reasonable ethical question whether intuitively human behavior should be subject to the same evidential procedures and demands as the application of tools and technologies. The standards of scientific evidence may not always appropriately apply to largely sociopolitical activities within health care..."

Given the cost of many public health interventions and high expectations from health promotion programs an evidence-based public health is highly desirable, providing that the expectations from health promotion programs an evidence-based approach either.

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Given the cost of many public health interventions and high expectations from health promotion programs an evidence-based public health is highly desirable, providing that the above mentioned challenges will be overcome and classical evidence-based procedures modified and further developed.

Muir Gray’s monograph represents a serious and innovative introduction of the evidence-based approach into community medicine and health care.

**EPIDEMIOLOGY IN EVIDENCE-BASED MEDICINE AND PUBLIC HEALTH**

Evidence-based approach in health sciences would not exist without modern fundamental and clinical epidemiology. It is clinical epidemiology put to good use at the largest possible scale. However, it is practiced now largely by an increasing network of educators who train others.

This fundamental role of epidemiology in evidence-based health sciences should be more explicitly recognized. Epidemiology deserves it. **Evidence-based practice is the use of epidemiological insight while studying and applying research, clinical, and public health experience and findings in clinical practice, health programs, and health policies.** This role is not often explicit enough, making EBM appear newer and more independent from its medical and epidemiological past and present than it really is.

One of present problems may be a terminological gap between epidemiology and EBM. For example, a more experienced reader will notice a common ground for various measures of risk in both fields:

<table>
<thead>
<tr>
<th>In evidence-based medicine</th>
<th>In epidemiology</th>
</tr>
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<tbody>
<tr>
<td>Relative risk reduction (RRR)</td>
<td>Etiological fraction (EF)</td>
</tr>
<tr>
<td>Absolute risk reduction (ARR)</td>
<td>Attributable fraction (AF)</td>
</tr>
<tr>
<td>Patient expected event rate (PEER)</td>
<td>Attributable risk percent (AR%)</td>
</tr>
<tr>
<td>Baseline risk</td>
<td>Protective efficacy rate (PER)</td>
</tr>
<tr>
<td>Risk difference (RD)</td>
<td>Etiological fraction (EF)</td>
</tr>
<tr>
<td>Baseline risk</td>
<td>Attributable risk (AR)</td>
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Only further experience will show if such a terminological dichotomy is necessary. The proposed evidence-based terminology is a translation of several classical epidemiological measures of strength and specificity of causal relationships which is applied to similar relationships in the field of clinical trials and assessment of the impact of medical interventions.

The key position of epidemiology in clinical evidence-based health sciences must be fully and explicitly recognized. If not, it may sometimes create a false impression in minds of many practitioners, that they do not need epidemiology. Everybody needs it.

Some confusion about “systematic reviews” in “evidence-based practice” may persist in minds of newcomers to the field of evidence-based health sciences. Let us not forget, that a systematic review is only one element in the whole process of the “evidence-based medicine and public health”.

The same applies to systematic reviews and **meta-analysis in medicine**, but to a much lesser degree. A decade ago we coined this field as a “systematic, organized and structured evaluation and synthesis of a problem of interest based on results of many independent studies of that problem ... in an epidemiological sense, the results of different studies become a new unit of observation and the subject of study is a new cluster of data, similar to groups of subjects in the original research. It is a study of studies or epidemiology of their results ... the third element of meta-analysis is the integration of its qualitative and quantitative findings...”. Once again, epidemiological thinking and methodology permeate this kind of research.
On the other hand, epidemiology may learn from the pragmatism of the evidence-based approach. Epidemiology was recently criticized for its limits, for overemphasizing its findings, and for taking its own methodological brilliance for its purpose. The evaluation of the relevance of current epidemiological research as a whole remains to be done. However, let us remember that exceptional findings rise from diversity.

Epidemiology suffers often from its “yes - but” approach. Let us not forget, that ultimately, as in clinical and public health practice, we have as scientists an obligation to consider and weight our uncertainty, but ultimately, as medical professionals, we must always make a “yes or no”, decision: we will operate, we will not operate, we will immunize or not, we will catheterize or not, etc. We are in our positions for this kind of decision making and it is expected from us.

CONCLUSION

We live in a period of a generalized soul searching. New paradigms have been proposed not only for the evidence-based medicine but also for public health, and epidemiology itself.

Evidence-based medicine remains a great beneficiary of epidemiology and it is one of its recent important outcomes and accomplishments. It is an important and relevant contribution to modern medicine. However, a lot of work remains to be done.

It should expand from the first groups of its builders and practitioners into the largest practice and widest use possible. In spite of its obvious benefits, there are many pitfalls, mostly in the eyes of the beholder:

* it may be embraced as something entirely new with a denial of epidemiology’s contribution;
* it may create an impression that a laptop multimedia computer over the shoulder of every clinician doing rounds means evidence-based medicine;
* it may produce two categories: research findings providers, and those who will tell them what their sweat is worth;
* it may become a simple mantra, used indiscriminately by many, just to make everybody look up to date and “scientific”;
* it may become simply a “colorized clinical epidemiology” for the largest audience of health professionals;
* it may shroud itself mostly in few periodicals devoted exclusively to EBM, instead of being present as often as possible in reputable journals addressing to a large professional readership.

Some practitioners of epidemiology feel that their discipline is in crisis. It is not. They are. Crisis in epidemiologists stems from the natural affinity of some people to develop methodology and others to apply and use epidemiological methods and techniques to bring answers and solve problems. If the former category of epidemiologists looks more successful than the latter, evidence-based medicine and evidence-based public health are two new directions for all who wish to put their savoirfaire (know how) and wealth of experience into good use, especially in defining general strategies against important health problems. Practitioners of various clinical specialties will bring them down into the individual patient care, be it risk assessment, screening and diagnosis, treatment or prognosis.

Some of us will reflect on national and international health statistics in a search for hypotheses of the nature of things. Some of us will search for causes through observational etiological studies. Others will be experimenting with interventions. Some will ask themselves how much does it cost. The rest of us will try to put all this together and to make a sense of it. It takes all these pieces of the puzzle to make the picture of what we are all looking for and perhaps a further refined paradigm of medicine today.

For epidemiologists looking to expand their horizons, evidence-based medicine is a challenge, a powerful stimulus and a blessing:

* It takes them beyond the classical framework of occurrence studies, etiological research, and clinical and public health trials and evaluation;
* it will value and put into good use their expertise, experience, and competency;
* it will require a certain degree of adaptation, of ways of thinking and additional training;
* it will stimulate epidemiologists to remain the best and essential contributors to a further development of EBM;
* it will rely on a full and genuine teamwork of epidemiologists with a wide array of clinical and other specialties.

As in any new endeavor, efforts and accomplishments of EBM are not equally spread across its steps and spectrum. However, let us remember EBM’s “youth”. From all steps of the evidence-based approach, we now know how best to search for the evidence and how to evaluate it. A clear indication how to link the best evidence to the best clinical and public health knowledge and experience remain to be clearly worded.

Operational criteria and cut-off points for the translation of the best evidence into the acceptable for practical decisions and translation into action are also not quite clear yet.

EBM is not alone in such a “waiting in line for universal embrace”: Clinical algorithms, practice guidelines, meta-analysis are currently subject to similar considerations.

EBM “... has recently been taken up by politicians and managers and is currently being packaged and promoted as a panacea, at the expense of medical science”. Many are “jumping the bandwagon”, many will leave it and, most probably, many will ride and coach it in the right direction.

For epidemiologists it may become one of its promised
lands, a put into another good use, their work and experience.

Ultimately, evidence-based medicine and public health should integrate several domains in terms of Figure 2.

To structure in operational terms such a way of doing things will be a great challenge in the next few years to come. Perhaps, our initiatives will even bear a quite different name than “evidence-based approach”. The name is much less important than what we are doing under the label of the day. The effect and impact of such endeavors of ours should be worthy in the first place.

The concept of evidence-based approach is a major contribution to medicine, but it does not replace it in its entirety. To refine it further, we must strive to be more than a jolly bunch having fun, however justified, with computers.

Such a “new medicine” and “new public health” are ambitious labels which should prove themselves only with time and through the widest possible learning, experience and practice. The take-off was successful, the landing should be equally good. Above all, EBM and EBPH should prove themselves beneficial and profitable for the patients and the populations to which we dedicate our skills, experience and commitment.

A remarkable work begun through an almost herculean effort of the first conceivers and protagonists of evidence-based medicine. The symphony is unfinished, its finale must still be written and played. In addition, the musicians must have their instruments well tuned. We are going through the period of tuning. Let us contribute to it both as composers and players. Let us wait with excitement for what the forthcoming years will bring from this domain into the new millennium.

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