JOURNAL OF INSURANCE MEDICINE

J Insur Med 2001;33:239–250

EVIDENCE-BASED MEDICINE

Evidence-Based Risk Assessment

Anthony F. Milano, MD, MPH

A knowledge framework for medical manual revision, competitive underwriting, accurate risk assessment, and precision decision making.

Address: Business Men's Assurance Company of America. P.O. Box 419076, Kansas City, MO 64141-6076

Correspondent: Anthony F. Milano, MD, MPH.

Key words: Evidence-based risk assessment.

Received: February 18, 2001.

Accepted: May 10, 2001.

An enormous amount of highly precise quantitative research and clinical evidence concerning diagnostic tests, preventive and therapeutic interventions, prognosis, and risks for adverse outcomes has become increasingly available in recent years. ''Insurance is a business where the strategic (development) and use of information about future events is the key element of profitability.''[1] Underwriting application of this evidence, however, has lagged behind, not only because of the traditionally slow dissemination of important new research findings[2] but also because of the frequently imprecise manner in which physicians think and communicate.[3] This lack of exactitude is now being modulated to some extent by several encouraging developments:

- Increasingly routine use by insurance medical directors of critical epidemiologic and biostatistical appraisal principles as applied to outcomes evidence in the medical literature;
- Wider application of traditional mortality methodology practices for analysis of survival data;
- Introduction and broader familiarization with terms such as sensitivity, specificity, relative risk, likelihood ratio, positive and negative predictive value, and confidence interval, etc.

A 1992 study by Naylor and colleagues[4] indicated that clinician perceptions of the impact of therapeutic interventions differed markedly depending on how the figures were presented. We believe that insurance companies and applicants are entitled to expect clearer thinking from their physician-advocates.

EVIDENCE-BASED RISK ASSESSMENT

Evidence-based risk assessment (EBRA) is the practice of making precision insurance medical decisions through the judicious identification, evaluation, and application of the most relevant, quantifiable, statistically valid, and actuarially sound clinical outcomes information. In a word, it is underwriting decision making based on the best clinical outcomes information available.

GOALS AND OBJECTIVES

The four principal goals of this paper are as follows:

Goal One

Outline a basic explanation of evidence-based risk assessment and the ways in which it differs from conventional underwriting by comparing traditional empirical decision making with systematic, rules-based, active, and participatory learning inherent in EBRA.

- Systematic on-line clinical information search and retrieval surveillance strategies for establishing a coherent global medicine R&D database with web browser access will be described.
- With access to MEDLINE and its clinical subsets, specialized compendia of studies, and systematic reviews of studies, current best evidence is becoming easier than ever to find.

Goal Two

Discuss the importance of rules-based evidence and data requirements for optimizing

- Scientific accuracy, assuring precision decision making for competitive market place positioning with sound business profitability, favorable mortality, and predictable survival;
- Constancy in underwriting processes by the application of life table methodologies;
- Simplicity in medical manual format and underwriting applications;
- Facilitation and direct employment of automated mortality methodology tools for the purposes of understanding impairment-specific patterns of survival and excess mortality.

Goal Three

Recognize the strengths and weaknesses of EBRA in terms of the impact of rules-based evidence on

- Quality decision making based on fact, benchmarking, and the dominance of profound knowledge;
- On-line information resource availability for appraisal of comparative mortality;
- Information suitability: filtered versus unfiltered data, peer review, etc.;
- Data applicability to select populations and insurance applicants;
- Training, time, and money requirements for on-line global medical research and development;
- Epidemiologic and biostatistical skill sets necessary for data interpretation and application to select insurance populations.

Goal Four

Systematize the articulation of common sense by detailing the 5 steps for practicing evidence-based underwriting:

- Formulate an explicit question to be researched;
- Streamline the search for valid statistical information;
- Create a choice, probability, and outcome framework for structuring the decision;
- Quantify and express probability and outcome data as absolute risk, relative risk, likelihood ratios;
- Construct a life table-based mortality abstract as the actuarial gold standard predictive engine of survival, life expectancy, mortality, and morbidity.

TRADITIONAL INSURANCE MEDICINE PARADIGM

The traditional insurance medicine paradigm comprises at least 7 overriding assumptions:

1. Risk assessment accuracy to assure favorable mortality and predictable survival;
2. Statistical calculation of the magnitude of risk for similar groups of medically impaired individuals employing life table-based mortality methodology applied to articles taken from the clinical literature;
3. Risk magnitude (RM) measurement—ab-

solute and relative risk mortality parameters
- Mortality ratio (MR)—a relative risk comparison of the observed to expected death rate;
- Excess death rate (EDR)—absolute risk comparison; observed minus the expected death rate;
- Life expectancy—number of years remaining at a given age[5];

Risk magnitude expression—relative risk (probabilities) and likelihood ratios[6];
- Relative risk—risk ratios, hazard ratios, odds ratios, multivariate analysis;
- Likelihood ratios—sensitivity, specificity, predictive values (positive and negative);
- Tables consisting of at least 5 columns of data[7];
  - Age (start-end for individual ages through a given number of follow-up years);
  - Years of exposure to 3 decimal places;
  - Annual number withdrawn;
  - Annual number of deaths;
  - Annual mortality rate to 4 decimal places;
- Cumulative survival rate to 4 decimal places;
- Bayesian poststudy probabilities expressed as risk ratios (RR), odds ratios (OR)[8];
- Likelihood ratios (LR) expressed as sensitivity, specificity, predictive value testing;
- Multivariate analysis to assess the magnitude of association between predictors and outcome variables;

4. Comparison of the impaired group with a select population to assure equitable pricing;
5. Measurement of the power of the assumptions and decision-making efficacy through claims analysis;
6. Calculation of premiums by creating bands of like risk from
   - Age-specific mortality ratios;
   - Additional premiums covering shorter risk periods are derived from excess death rates;
   - Depending on the product or company, bands of like risk range from preferred or select to standard and substandard degrees of projected extra mortality expressed as debits in 25% increments to as high as 500% or more.
7. Individual underwriting experience providing the foundation for decision making and the measure of authority is proportional to the weight of individual experience.

CURRENT COMPETITIVE REALITIES

In recent years, market-based competitive pressures have modified the foundational principals of traditional insurance mortality assumptions:

1. The 1989–91 US Population Life Tables have been released and actuaries can estimate updated life expectancies for likely purchasers of life insurance.
2. Premiums based on select tables are exorbitant for the majority of substandard lives with medical impairments resulting in a loss of unimpaired lives to other investment products and antiselection due to inadequate premium income from the insurance pool.
3. Reinsurers seem to be competing for the same group of substandard lives as direct writers.
4. Direct writers of life products, reinsurers, and brokerage houses calculate broad bands of mortality and impairment-specific extra mortality but also modify the rating by identifying debits or credits.
5. The impetus is to reduce the rating, thereby reducing the premium to become more competitive.
6. Underwriters frequently appraise the specific risk of the proposed insured and not simply place a generic life table-based assessment contained in the medical manual by individually examining as many aspects as possible of the clients clinical history, physical examination, laboratory

tests, and screens, diagnosis, treatment, complications, comorbidities, and prognosis.
7. In moving from global/generic to applicant-specific projected outcomes, mortality ratios are being tailored to the specific risk expectations of an individual applicant.

EVIDENCE-BASED INSURANCE MEDICINE PARADIGM

An evidence-based insurance medicine paradigm comprises an additional set of assumptions:

1. Rules-based data requirements exist: information derived from systematic, reproducible, and unbiased current studies to increase their confidence in the true, individual applicant-specific prognosis, efficacy of therapy, and usefulness of diagnostic tests and treatments for competitive underwriting:
   - A global understanding of pathophysiology is necessary but insufficient to predict mortality and survival end-outcomes for the practice of insurance medicine.
2. Criteria of suitability of clinical studies for insurance medicine have been well covered in articles published in the *Journal of Insurance Medicine* by Singer and Kita.[9]
   - ''Guidelines for evaluation of follow-up articles and preparation of mortality abstracts,'' *Journal of Insurance Medicine,* 1991, reprinted as Chapter 4 in *Medical Risks—1991 Compend of Mortality and Morbidity.*
   - The article by Dr Kita is particularly useful because it contains follow-up article evaluation checklists geared to finding suitable articles for mortality abstraction.[10]
   - In article evaluation, such demographically appropriate topics as condition studied, classification, size of series, type of follow-up study (prospective study, historical prospective study, randomized clinical trials, case control studies, retrospective studies), formation of the series, demographic data at entry, follow-up notes, classification of patients or subjects, deaths observed, derivation and presentation of results, significance tests, article references, and potential value of the follow-up article are clearly explained.
3. Abstract preparation (formal or informal), duration questions, age/sex and other patient groupings, need for additional data, expected mortality choices, table construction based on life table data, tables based on cumulative survival curve data (tabular P data, graphic survival curve data, and graphic survival curve with values of 'e' by duration).
4. Comparative and composite mortality tables also examined by Drs Singer and Kita were associated with clinical trials, intraseries comparison, abridged risk ratio data, case control studies, attained age cohort, and organizing or combining data from several articles into a composite abstract.
   - Quite a few insurance medicine examples of this sort may be found in the new mortality reference monograph by Lew and Gajewski, *Medical Risks.*[11] One example is abstract 648, including several series of patients with single vessel disease after coronary by pass surgery (CBPS). Post-CBPS patients are analyzed with respect to age and sex.
   - Valid composite abstracts depend on the nature of the data and the desired objectives and it is therefore difficult to detail general instructions for combining data.
5. Best evidence validity—data must be
   - Relevant: extend or refine existing knowledge;
   - Generalizable: applicable to general and insurance populations;
   - Definitive: conclusive and compelling, not preliminary or tentative;
   - Adequately sized: statistically and actuarially valid;
   - Data quality: rules based, actuarially and methodologically sound.
6. Understanding mortality methodology

(rules for converting survival data to mortality) is necessary to evaluate and apply clinical literature outcomes to evidence-based insurance medicine.
- Life table methodology by Pokorsky in Chapter 2 of *Medical Risks—1991*.[12]

7. EBRA supplements but does not replace experience-based underwriting because it integrates mortality and survival analysis with experience from multiple ''experts'' in the clinical and insurance domain for aggressive, applicant-specific decision making.
8. EBRA is global medical literature-based, explicitly referenced, packaged, and maintained in the electronic medical directory. The strategic cornerstone of global medicine R&D is composed of 3 professional and academic pillars:
   a. The systematic surveillance of virtual library resources[13] in order to
      - Prospectively identify and critically review relevant published studies in several clinical areas likely to affect the practice of insurance medicine;
      - Maintain broad familiarity with the most reliable medical literature;
      - Keep web access to the largest and most respected national and international bioscientific, medical, public health, epidemiologic, and biostatistical databases available on your web browser/favorites list.
   b. Global Medicine Database access in order to
      - Develop on-line search expertise and www.virtual library resources for finding specific information to answer focused clinical questions on matters mortality;
      - Identify government agencies, university sites, professional societies and organizations for cancer, diabetes, infectious diseases, AIDS, genetics and molecular biology, biostatistics and mathematical modeling, computing resources, related sites.
   c. Regular real-time browsing to
      - Choose a manageable number of peer-reviewed core journals that publish studies relevant to insurance medicine and relating to national and international underwriting regarding matters mortality; for an incomplete, example see below.

PURPOSES OF EVIDENCE-BASED UNDERWRITING

1. Simply, accurately, and consistently classify risk for precision decision making;
   - Ideally, the newest professional would handle a competitive underwriting situation in the same manner as a seasoned professional.
2. Use applicant-specific—personal versus generic—evidence-based mortality and survival analysis by
   - Age, sex, disease extent, severity, complications, comorbidities, risk factors.
3. Capture improving forecasts of individual lifetimes for competitive advantage by
   - Increasing median survival times for many impairments;
   - Taking into account the impact of improved diagnosis, treatment, preventive medicine on longevity and lower mortality.
4. Scientifically secure the competitive benefit of current standard population tables versus select tables for expected mortality (q′).
5. Facilitate positive longevity adjustment for all-cause mortality in favorable cases by
   - Indirectly adjust observed survival rate to remove the effect of normal mortality;
   - Account for the risk of dying from other causes, divide the annual observed survival rate by the expected (normal) rate.[14]
6. Use real-time leveraging of the scientific core-body of insurance medicine with the on-line power of profound knowledge for competitive pricing, favorable mortality, and predictable survival.

7. Optimize competitive and accurate underwriting by
   - Standard risk pools being maintained and increased;
   - Impaired risk pools being limited by diminished antiselection.
8. Change the ''culture of learning'' from passive and receptive to active and participatory.
9. Reemphasize the science of insurance medicine so that decisions
   - Are rules-based for accurate and consistent decision making;
   - Are based on benchmark standards;
   - Are made within a framework for improvement;
   - Take into account information overload and the need for synthesis;
   - Provide credibility in an age of pragmatic physician-client relationships.
10. Enhance strong, competitive regional or global marketplace influences!

EBRA and Traditional Underwriting Compared

	EBRA	Traditional Underwriting
Decision making	Fact-based	Empirical, passive, receptive, historic data, characterized by
	Active	Dogmatism: The manual says to 'do it this way.'
	Participatory	Policy: We do it this way around here.
	Systematic	Experience: I haven't gotten too many claims.
	Precision-driven	Nihilism: It doesn't really matter what you do.
	Benchmark standards	Rule of least chagrin: Do what you'll regret least.
	Real-time date	Defer to experts: How would you do it?
	Sound judgment	Defer to clients: What would you like us to do?
	Profound knowledge	Whim: This way might work.
	Personalized	Generic
	Competitive	Generally protective
Information leveraging	All products	Difficult
Information accuracy	Rules-based outcomes	Empiric and intuitive, occasionally rules based
Decision accuracy	Rules-based data	Empiric and passive (''see one, do one, teach one'')
	Balanced evidence and experience	Worst of all, ''What's your guess?''
Decision consistency	Evidence-based validity	Empiric, unsystematic
Database	Referenced	Plagiarizes the competition (frequently)
	Data ÷ denominator	Danger of random knowledge, random data
	Electronic	Paper
Real-time global R&D	Surveillance strategies	Haphazard if at all
Mortality methodology	Automated	Hand-held calculator, or 'quick-hit,' or empiric
Expected mortality (q')	Population	Population or 75–80 S&U or 1980 CSO
Market impact	Competitive, proactive	Dated, reactive, status quo
	Profit oriented	Protection oriented

BASIS OF COMPETITIVE UNDERWRITING

- Real-time, fact-based, benchmarked standards of improved clinical outcomes and longevity
- Personalized versus generic risk assessment by age, sex, diagnosis, extent, severity, treatment, etc.
- Current standard population tables used for derivation of expected mortality (q')
- Automated mortality methodology for virtually real-time decision making and customer service.

STRENGTHS OF EBRA

Organizations and Applicants

- Uses rules-based evidence: reduces empiricism, improves accuracy, reduces uncertainty (the largest single cause of mistakes), enhances medical director authority, provides a framework for continual knowledge updating, and measures outcomes against scientific standards
- Provides on-line information resource availability
- Can be performed by practitioners on the job
- Lets insurance applicants enjoy higher face amounts at lower premiums
- Provides insurance organizations with a scientific rationalization of the competitive power of POSH (programs offering substandard help)
- Optimizes the ''power of balance'': good data integrated with sound professional judgment
- Lets predictably favorable mortality and survival be scientifically preserved
- Provides a basis of knowledge-based systems for nonmedical underwriting and logical decision making[15]
- Facilitates development and integration of expert modules of insurance information with systems for electronic distribution of programmed decision making[16]
- Enhances Markovian analysis to improve forecasts of individual lifetimes (a good example is the Markovian model by Vijan and colleagues describing the transition probabilities of retinopathy to blindness and proteinuria to end-stage renal disease related to elevated levels of hemoglobin A1C and advancing age-onset of diabetes mellitus)[17]
- Protects against the C-2 risk of mispricing[18]

Insurance Medical Directors

- Allows continual update of clinical knowledge, information, and search skills
- Improves the quality of risk selection
- Improves the consistency of risk selection
- Makes the best use of existing knowledge for risk selection
- Reduces uncertainty to the extent possible

WEAKNESSES OF EBRA

- Not a lot of good (rules-based) evidence, can't study everything
- Not a lot of generalizable evidence, population to population
- Not a lot of generalizable evidence, population to individual patients
- Lower margins associated with lower individual premium income (offset, however, by higher volume and expected lower claims ratios)
- Practitioners require training, hardware, and software—data requires interpretation

UNDERSTANDING EVIDENCE RESOURCES[19,20]

Prefiltered (Rules Based and Peer Reviewed)

- Medical literature, research center computer databases, personal experience, colleagues, professional experts, industry experts (*Medical Risks, Journal of Insurance Medicine, On The Risk*)
- Quality medical information considered reliable, accurate, current, applicable to patients and settings, and accessible

Need to Differentiate

- Evidence versus opinion
- Editorial versus advertising
- Education versus promotion, science versus hype
- Core standards answer the question of how good the evidence is and include authorship credentials, attribution (references, sources, evidence hierarchy, etc.), disclosure (sponsorship, commercial interests, conflicts, etc.)

Unfiltered—Internet Evidence

- ''User beware'' caveat: failure to meet scientific criteria

- Many aspects, from many sources, creating many web sites
- Available to patients, physicians, and organizations
- *New York Times, Los Angeles Times, Wall Street Journal,* etc, obviously not peer reviewed
- Enormous data (not information—data ÷ denominator) volume with rapid turnover and change
- Peer review/oversight is lacking or not even feasible
- Questionable scientific and statistical validity
- Web site validity is difficult to assess—flashy logos
- Misleading or out-of-context information

Hierarchy of Evidence[21]

1. Anecdotal case reports
2. Case series without controls
3. Series with literature controls
4. Analyses using computer databases
5. Case control observational studies
6. Series based on historical control groups
7. Simple randomized control trials
8. Confirmed randomized control trials including meta-analysis
9. Meta-analysis with original data

Synthesizing Evidence

- Narrative reviews, systematic reviews, meta-analysis, decision analysis, cost-effectiveness analysis, clinical practice guidelines, algorithms

Narrative Reviews

- Panoramic view: usually covers the whole topic, ie, textbook chapters
- Emphasizes background knowledge: What causes the disorder, what are the clinical manifestations, what are the treatment options available?
- Susceptible to bias in selecting, appraising, and combining studies to answer questions

Systematic Reviews

- Telescopic view: usually addresses only one or a few questions
- Focus on 'foreground' knowledge, eg, comparing two available treatment options for outcomes efficiency
- Rigorously minimizes bias and improves reliability and accuracy of conclusions
- Can provide pooled estimates of risks and benefits

Meta-analysis[22–24]

- Systematic review and summary statistical analysis of the results of several studies testing the same relationship
- Combining the studies provides a larger sample for analysis and greater statistical power
- Used to increase the evidence for, or confidence in, a conclusion

Evidence Validity

Relevant, generalizable, definitive, adequate size sample, data quality.

ABBREVIATED LISTINGS OF MEDICAL WEBSITES/RESOURCE CENTERS AND CONTACT INFORMATION[25]

OVID http://gateway.ovid.com/
WWW Virtual Library
http://www.ohsu.edu/cliniweb/wwwvl/all.html
List of Clearinghouses
http://www.nlm.nih.gov/medlineplus/clearinghouses.html

Government Agencies[26]

National Health Information Resource Center—An Index to Health Statistics Web Sites
http://www.ari.net/nhirc/hds.html
NIH http://search.info.nih.gov/
AHRQ http://www.ahrq.gov/
NIH/National Library of Medicine
http://www.nlm.nih.gov/medlineplus/

CDC National Prevention Information Network
http://www.cdcnpin.org/
National Center for Complementary and Alternative Medicine Clearinghouse
http://nccam.nih.gov/nccam/clearinghouse/
CancerNet (National Cancer Institute)
http://cancernet.nci.nih.gov/
Clinical Trials
http://www.nih.gov/health/trials/index.htm
http://clinicalstudies.info.nih.gov/
Cancer Trials
http://cancertrials.nci.nih.gov/
The Combined Health Information Database
http://chid.nih.gov/

Health Information Rating Sites

OncoLink Editor's Choice Award
http://www.oncolink.upenn.edu/ed_choice/
Health on the Net Foundation Code:
http://www.hon.ch/HONcode/
The Argus Clearinghouse
http://www.clearinghouse.net/
The Health Summit White Paper
http://hitiweb.mitretek.org/docs/criteria.html
Also See Table 1 in *JAMA* article by Jadad AR and Gagliardi A for sites and their evaluations[27]

On-Line Journals

PubMed (free Medline)
http://www.nlm.nih.gov/databases/freemedl.html
Listings of Journal Links
http://webmedlit.silverplatter.com/sources.html
Annals of Internal Medicine
http://www.acponline.org/journals/annals/annaltoc.htm
BMJ, British Medical Journal
http://www.bmj.com/
Evidence-Based Medicine
http://www.acponline.org/journals/ebm/
Emerging Infectious Diseases
http://www.cdc.gov/ncidod/eid/index.htm
Family Practice
http://www3.oup.co.uk/famprj/contents/
JAMA http://pubs.ama-assn.org/
Journal of Family Medicine
http://www.ccspublishing.com/j_fammed.htm
The Lancet http://www.thelancet.com/
New England Journal of Medicine
http://www.nejm.org/content/index.asp
Pediatrics http://www.pediatrics.org/
Morbidity and Mortality Weekly Report (*MMWR*)
http://www2.cdc.gov/mmwr/
Nature http://www.nature.com/
Science http://www.sciencemag.org/

REGULATIONS

Massachusetts DPH HIV Reporting
http://www.magnet.state.ma.us/dph/aids/hivsrvfq.htm
http://www.state.ma.us/dph/dphhome.htm
State Notices to Providers
http://www.magnet.state.ma.us/dph/dphprov.htm
Guidelines for the Conduct of Research Involving Human Subjects at the NIH (Revised 3/2/95)
http://helix.nih.gov:8001/ohsr/guidelines.php3

PRIVATE SITES AGGREGATE MATERIALS

(**Caution:** disclosure is limited—these are only samples, not endorsements)

Medscape http://www.medscape.com
WebMD
http://www.webmd.com/pressrelease/index.html
Hardin Meta Directory
http://www.lib.uiowa.edu/hardin/md/index.html

SEARCH ENGINES/STRATEGIES LISTINGS

WWW—Virtual Library
http://www.ohsu.edu/cliniweb/wwwvl/index.html
http://www.ohsu.edu/cliniweb/wwwvl/all.htmll
Library of Congress Listings
http://lcweb.loc.gov/global/search.html
Guide to Searching on the Web
http://www.thewebtools.com/tutorial/tutorial.htm
Search Engine Watch (listings and tips)
http://searchenginewatch.com/
Search Engine Features (at a glance)
http://searchenginewatch.com/facts/ataglance.html
How to Search for Medical Information
http://204.17.98.73/midlib/www.htm
To Translate Web Pages
http://babelfish.altavista.digital.com/cgi-bin/translate?
AltaVista http://www.altavista.com/
Excite http://www.excite.com/
Yahoo http://www.yahoo.com/
HotBot http://hotbot.lycos.com/
MetaCrawler
http://www.metacrawler.com/
ProFusion
http://www.profusion.com/
Ask Jeeves
http://www.askjeeves.com/
SavvySearch
http://www.savvysearch.com/
Cyber411
http://www.c4.com/index.html?cyber411=1

PAIN-RELATED SITES

AHCPR Low Back Pain Guideline
http://text.nlm.nih.gov/ftrs/tocview
http://text.nlm.nih.gov/ftrs/pick?dbName=lbpc&ftrsK=50861&cp=1&t=952117385&collect=ahcpr
Cancer Pain Education Resource (CAPER)
http://www.caper.tufts.edu./
National Foundation for the Treatment of Pain
http://www.paincare.org/
American Academy of Pain Medicine
http://www.painmed.org/
The Oxford Pain Internet Site
http://www.ebando.com/painres/painpag/index.html
International Association for the Study of Pain
http://www.halcyon.com/iasp/
http://faculty.washington.edu/crc/CRCpage/patients.html
Back Pain PORT
http://www.ahrq.gov/clinic/medtep/backpain.htm#backpainimp
The American Pain Foundation
http://www.painfoundation.org/

COMPUTING RESOURCES

Epi Info Technical Support
(eppiinfo@orkland.em.cdc.gov)

FIVE STEPS FOR PRACTICING EVIDENCE-BASED RISK ASSESSMENT

(Systematize the articulation of common sense)

1. Formulate an explicit, clinically relevant, and sufficiently focused question to search follow-up studies in the clinical literature identifying
   - The diagnosis or condition
   - Universe of patients (population and setting)
   - Interventions (test, treatment, exposure)
   - Statistical or probability outcomes of interest
2. Streamline the search for statistical evidence by
   - Classifying the question into a survival, mortality, or probability outcome domain related to diagnosis, therapy, or prognosis
   - Do a planned, systematic search for the statistical evidence using prefiltered resources, unfiltered internet resources, practical surveillance approaches, and global medicine research and development strategies

3. Create a choice, probability, and outcome framework for structuring the decision and sequence the decision process[28,29]
   - Define the question *What needs to be changed?*
   - What is known? *Evidence*
   - What do we want to do? *Guideline change*
   - How can we do it? *Implementation*
   - Does it work? *Outcomes*
4. Fill in the data: apply the principles of mortality methodology and probability analysis to
   - Quantify absolute risk: mortality ratios, survival ratios, excess death rates
   - Express relative risk: risk ratios, hazard ratios, odds ratios, multivariate analysis
   - Express likelihood ratios: sensitivity, specificity, predictive value (positive and negative)
5. Automate mortality methodology and construct a mortality abstract
   - Evaluate patterns of survival and mortality: annual, quinquennial, decennial
   - Make a decision
   - Perform sensitivity analysis: 'one way' variable—my decision could be better if . . .
   - Assess the robustness of your decision (does it make sense?)
   - Look at Markov processes: transition periods representing the natural history of disease

REFERENCES AND THE REVISED MEDICAL MANUAL[30]

References are numbered consecutively as they are cited and hyperlinked in the electronic directory for ease of access. The style of references is that of *Index Medicus* but categorized by subject in this section. Such a reference section, systematically presented, is arguably the most important and effective academic tool for insuring the integrity of the knowledge database, as it contains the original information font with contributing authors and researchers for scientifically validating evidence-based medical underwriting standards and legitimating underwriting decision making.

CONCLUSION

Medical knowledge is expanding exponentially. The constant and systematic practice of evidence-based risk underwriting in the 21st century is absolutely essential for precision decision making to profitably exploit the dominance of profound knowledge in the market place. Acquiring the skill sets and learning to access, manipulate, interpret, and apply this knowledge appropriately is a daunting but unavoidably critical task for medical directors. An accurate way of characterizing evidence-based underwriting is not as a paradigm shift but rather as an evolution of the tools used to practice insurance medicine. Our assumption is that the explicit knowledge framework of EBRA will lead to improved mortality and survival outcomes, meet and exceed customer needs, and provide a greater level of practice satisfaction for medical directors.

With market competition at fever pitch, fundamental tensions may exist between applicant needs, equity preservation, accurate (neither liberal nor conservative) underwriting, and organizational goals. Ideally, evidence-based risk assessment for competitive decision making considers principals of equity and ethics that incorporate the utilitarian perspective of doing the most good for the most people.

REFERENCES

1. Stone DA. At risk in the welfare state. *Soc Res.* 1989;56:591–633.
2. Antman EM, Lau J, Kupelnick B, et al. A comparison of results of meta-analyses of randomized control trials and recommendations of experts. *JAMA.* 1992;268:240. [PMID 1535110]
3. Kassirer JP. Clinical trials and meta-analysis. What do they do for us? [Editorial]. *N Engl J Med.* 1992; 327:273–274.
4. Naylor CD, Chen E, Strauss B. Measured enthusiasm: does the method of reporting trial results alter perceptions of therapeutic effectiveness? *Ann Intern Med.* 1992;117:916.

5. Singer RB. A method of relating life expectancy in the U.S. population life-table to excess mortality. *J Ins Med.* 1992;24:32–41.
6. Kita MW. Odds and ends: minding your P's and Q's. *J Ins Med.* 1994;26:339–346.
7. Singer RB. How to construct a mortality abstract. *J Ins Med.* 1998;30:28–38.
8. Wesley D, Kita MW. Introduction to probability methods and concepts. *J Ins Med.* 1991;23:16–20.
9. Singer RB, Kita MW. Guidelines for evaluation of follow-up articles and preparation of mortality abstracts. *J Ins Med.* 1991;23:21–29.
10. Kita MW. Morbidity and mortality abstraction: finding suitable articles. *J Ins Med.* 1990;22:287–288.
11. Lew EA, Gajewski L, eds. *Medical Risks: Trends in Mortality by Age and Time Elapsed.* New York, NY: Praeger, 1990.
12. Pokorski RJ. Mortality methodology and analysis seminar. *J Ins Med.* 1988;20(4):20–45.
13. Friedland DJ, Go AS, Davoren JB, et al. *Evidence-based Medicine: A Framework for Clinical Practice.* Stamford, Conn: Appleton & Lange; 1998:145–150.
14. Shambaugh MA, Young JL, Zippin C, et al. *Statistics and Epidemiology for Cancer Registrars.* Book 7. SEER Program Self-Instructional Manual for Cancer Registrars. NIH Publication no. 94-3766. Cancer Statistics Branch, National Cancer Institute, US Department of Health and Human Services, Public Health Service, National Institutes of Health.
15. DeTore AW. An introduction to expert systems. *J Ins Med.* 1989;21:233–236.
16. Howman PM. CLUES: comprehensive life underwriting expert system. *J Ins Med.* 1989;21:237–242.
17. Vijan S, Hofer TP, Haward RA. Estimated benefits of glycemic control of microvascular complications in type 2 diabetes. *Ann Int Med.* 1997;127:788–795.
18. Cowell M. Morbidity, mortality, and the C-2 risk. *J Ins Med.* 1994;26:313–316
19. Hunt DL, Jaeschke R, McKibbon KA. Users' guide to the medical literature: XXI. Using electronic health information resources in evidence-based practice. *JAMA.* 2000;283:1875–1879.
20. Hayward R, Hayward RS, Wilson MC, Tunis SR, et al. Users' guides to the medical literature . . . Are the recommendations valid? *JAMA.* 1995;274: 570–574.
21. Olkin I. *J Clin Epidemiol.* 1995;48:135.
22. Lang TA, Secic M. *How to Report Statistics in Medicine.* Philadelphia, Pa: American College of Physicians; 1997.
23. Kassirer JP. Clinical trials and meta-analysis. What do they do for us? [Editorial]. *N Engl J Med.* 1992; 327:273–274.
24. Dickerson K, Berlin JA. Meta-analysis: state-of-the-science. *Epidemiol Rev.* 1992;14:154–176.
25. Zucker D. Finding and evaluating web-based evidence: using pain treatment as a case study. Seminar, March 16, 2000. Program jointly sponsored by Tufts Managed Care Institute and Tufts University School of Medicine. Funded in part by The Agency for Health Care Research and Quality grant, Training Evidence-based Practitioners (R25 HS09796). Compiled by Deborah Zucker, MD, PhD, NEMC, February 23, 2000.
26. http//:www.epibiostat.ucsf.edu/epidem/epidem
27. Jadad AR, Gagliardi A. Rating health information on the internet: navigating to knowledge or to Babel? *JAMA.* 1998;279:611–614.
28. Pauker SG, Kasssirer JP. Decision analysis. *N Engl J Med.* 1987;316:250.
29. Sox HC Jr. *Medical Decision Making.* Butterworth Heinemann, 1980.
30. Milano AF. Revising the medical underwriting manual: a leadership initiative in real-time. *On the Risk.* 1998;14(3):42–58.

Evidence for Risk Estimate Precision: Implications for Individual Risk Communication. Behavioral Sciences & the Law, Vol. 33, Issue. 1, p. 111.Â Referrers' views of structured professional judgement risk assessment of sexual offenders: A qualitative study. Journal of Sexual Aggression, Vol. 20, Issue. 1, p. 94. tive evidence-based RE risk assessment, we need data that allows us to infer, at least with a certain level of condence, those eects certain problems have based on a selection of specic context-specic conditions that characterise a project situation at any point in time. 8 D. MÂ´endez FernaÂ´ndez et al. From Cause-Eect Chains to Conditional Probabilistic Distributions. Finally, to lay the foundation for an evidence-based risk assessment which includes oper-ationalisable conditional dependencies, we analyse the data by making use of Bayesian networks. We already made positive experiences in using Evidence-based practice (EBP) is the objective, balanced, and responsible use of current research and the best available data to guide policy and practice decisions, such that outcomes for consumers are improved. Used originally in the health care and social science fields, evidence-based practice focuses on approaches demonstrated to be effective through empirical research rather than through anecdote or professional experience alone. An evidence-based approach involves an ongoing, critical review of research literature to determine what information is credible, and what policies and practice Evidence-Based Decision Making. Risk Assessment. Risk Assessment and Dental Treatment Planning. Heritable Conditions. Systemic Disease as a Risk Indicator for Oral or General Health Problems.Â Programs and practices put into place to promote these goals should be evidence based and should also include a careful assessment of disease risk and treatment outcomes. An analysis of both disease prognosis and treatment prognosis is also integral to this process. These three concepts risk assessment, outcomes assessment, and prognosis determination will all be defined and described, and their relevance to dental treatment planning will be discussed.