

Writing a Review Article for *AJRCCM*

The major pulmonary and critical care journals publish more than 5,000 articles every year. To read these would require more than 25 hours each week. Despite the surfeit of information, the average physician is starving for wisdom. The aim of scholarship is to increase understanding, not just accumulate discrete facts. A stack of papers no more conveys wisdom than a pile of bricks makes a house.

If new research is to improve patient care, reports need to be fitted into the mosaic of existing knowledge. General medical journals, such as the *New England* or *Annals*, publish a much higher proportion of review articles than do subspecialty journals. But the audience for a subspecialty journal is different from a general medical journal. The first rule of writing is to identify your audience. Review articles that appeal to general physicians are unlikely to satisfy subspecialists, who are expected to have a more detailed and nuanced understanding of subjects in their field.

The first step in writing a review article is selecting a suitable subject. Authors of a review article in *AJRCCM* may pick a broad field suited to a comprehensive overview in a State-of-the-Art (1–14), encapsulate a surge of rapid progress in a Pulmonary Perspective (15–30), turn a searchlight on an overlooked subject in a Critical Care Perspective (31–40), capture advances in related fields in an Update in Nonpulmonary Critical Care (41–53), convey practice pearls in a Clinical Commentary (54–63), share the secrets of scientific discovery in a How it *Really* Happened (64–78), or comment on a social conundrum in an Occasional Essay (79–83). By definition, a review article does not include original data. Yet, the perspective should be fresh and the synthesis unique. Authors must avoid a rehash of views expressed in existing reviews.

When writing a state-of-the-art review, the author needs to amass and synthesize a huge number of original reports. The skill is akin to that of a landscape artist. When ranging over a great sweep of scenery, the naked eye takes in millions of shapes, shades, and textures. The painter reduces this complexity to a few hundred brush strokes through ruthless selection, intensifying some contours, ignoring others, and reordering and harmonizing the relationships between elements. Great compositional skill is needed to place the elements in a coherent space, avoiding discontinuities and depth-of-field distortions, and construct a unified and expansive canvas that achieves realistic verisimilitude.

Likewise, the author of a comprehensive review article stands back to form a panoramic view of a broad field. He or she sifts through a mass of miscellaneous detail, selecting the most relevant, and omitting trifling reports and ephemeral fads. The value of the article depends as much on the dross and minutiae omitted as on the pearls included. The author does not cover every report in a field, because all are not of equal quality. In contrast to the deluge of references generated by a PubMed search, the good review article serves as a quality filter, directing the reader to the most influential journal and book literature. An author's selection of primary and secondary literature also conveys the legitimacy of his or her framework.

One of the most difficult tasks in writing a review article is finding the best structure because manuscripts do not follow the fixed formula (introduction, methods, results, discussion) of research reports. The structure should facilitate sequential unfolding of ideas in a logical order. To avoid getting lost mid

journey, readers need to know where an author is coming from and where he or she is going. The best structure may not become obvious until several drafts have been written; indeed, the failure to change the structure during the course of writing is a warning that it is likely wrong.

Taking the mass of raw reports, the author classifies, interprets and integrates the material, shaping it into a compact product that is more manageable for the reader. The author moves back and forth between the universal and the particular, alternating between use of a telescope and a microscope. He or she selects studies that are especially insightful, and locates them in the overall pattern. A major challenge is compression: how to take a tangled mass of facts, eliminate those that do not enhance understanding, and weave the remaining threads into a seamless fabric. The good review article is not a compendium of sequential studies in the manner of "Smith found this and Jones found that." Instead, the author integrates broad conceptual ideas into a narrative, and the primary investigators disappear into the prose.

Another challenge is how to write sentences that form a linear sequence, one connected to the next by a logical extension of thought. Sustaining reader interest over the course of a long review requires the skill of a storyteller. A good narrative pulls readers along without them noticing the tug.

Some journals classify narrative review articles as less reliable and of lower intellectual caliber than "systematic reviews" (84). The compulsive tracking down of every trial on a topic is imperative when writing a review article on the basis of a metaanalysis of randomized clinical trials; it is also important to tabulate numbers, inclusion and exclusion criteria, and other such detail of the trials. A scrupulous search system might be expected to limit bias, although vigilant peer review will afford greater reassurance against this flaw (85–88). The uniformity of the approach to writing such review articles enables a formulaic presentation. But the compulsive retrieval of every original paper is only one essential when writing a review article (and the least challenging). A punctilious listing of every detail produces prose that is prolix. It may also detract rather than enhance understanding, which is based on being able to see a forest among the trees. A catalog approach is ill suited to communicating a deeper understanding of biological principles garnered from the commingling of molecular research in animals with bedside studies of pathophysiologic mechanisms in patients. A catalog approach is inappropriate for subjects reviewed in *Nature Medicine*, *PNAS*, *JCI*—and most subjects reviewed in *AJRCCM*. That a review article does not carry the epithet "systematic" is not to say it was written in a desultory manner and the presentation chaotic. The skills in writing a narrative review are more intellectual than mechanical. Teams of "systematic reviewers" of questionable provenance are no substitute for wisdom derived from years of marinating in a subject and reflecting on its complexities. The worth of the final product depends on the author's conceptual sophistication, power of apprehension, cogency of analysis, sense of proportion, skill in condensation, explanatory force, and felicity of exposition—qualities not emphasized in "quantitative systematic reviews" (89–91).

A reader's best guide that a review article will be worth reading is a foreknowledge of the journal's peer-review standards (92). At *AJRCCM*, peer review starts when the author submits a letter of intent and an outline of a planned article. (Details of information to include in a proposal are provided

in our *Instructions for Contributors*.) Proposals are reviewed anonymously by six or more experts. Many proposals are declined, and authors getting a green light are also given concrete recommendations for improving the planned manuscript. Completed manuscripts undergo rigorous peer review and only the fraction satisfying the highest standards is published. The criteria differ from those used for original research reports. Referees of research reports focus on novelty of a hypothesis, rigor of experimental design, soundness of the methodology, approach to data analysis, and plausibility of the findings. With a review article, referees evaluate the importance and relevancy of the subject, comprehensiveness of the author's coverage, emphasis given to individual studies, legitimacy of the analyses, new insights and ideas being offered, ability to synthesize and integrate disparate observations, and the cogency and lucidity of the prose.

Scientific journals rightly set great store on original research. But much research consists of mopping up operations (93), and the amount of truly new information is less than we think. George Stigler (94), the 1982 Nobel Laureate in Economics, pointed out that "originality is a more complicated virtue than most discussion seems to recognize, and that its role in progress is not easy to state or assess." He continues that, "originality may also impair progress. Originality means difference, not improvement, and one may invent new errors as well as new truths." Moreover, new truths do not emerge fully formed. Accordingly, review articles help advance science. Progress in science depends on a certain aging process, whereby earlier findings are reanalyzed, previously undetected ambiguities are identified, residues of truth are extracted before a disproved theory is discarded, concepts are refined, and the range of applicability of new ideas is identified. *AJRCCM* contributes to a bountiful harvest of research reports. We hope that our review series also speed up scientific fermentation.

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References

- Mehta S, Hill NS. Noninvasive ventilation. *Am J Respir Crit Care Med* 2001;163:540-577.
- Marcus CL. Sleep-disordered breathing in children. *Am J Respir Crit Care Med* 2001;164:16-30.
- Hunt CE. Sudden infant death syndrome and other causes of infant mortality: diagnosis, mechanisms, and risk for recurrence in siblings. *Am J Respir Crit Care Med* 2001;164:346-357.
- Pedersen S. Do inhaled corticosteroids inhibit growth in children? *Am J Respir Crit Care Med* 2001;164:521-535.
- Lee WL, Downey GP. Leukocyte elastase: physiological functions and role in acute lung injury. *Am J Respir Crit Care Med* 2001;164:896-904.
- D'Ambrosio D, Mariani M, Panina-Bordignon P, Sinigaglia F. Chemokines and their receptors guiding T lymphocyte recruitment in lung inflammation. *Am J Respir Crit Care Med* 2001;164:1266-1275.
- Gattinoni L, Caironi P, Pelosi P, Goodman LR. What has computed tomography taught us about the acute respiratory distress syndrome? *Am J Respir Crit Care Med* 2001;164:1701-1711.
- Wang H, Yang H, Czura CJ, Sama AE, Tracey KJ. HMGB1 as a late mediator of lethal systemic inflammation. *Am J Respir Crit Care Med* 2001;164:1768-1773.
- Leung RS, Bradley TD. Sleep apnea and cardiovascular disease. *Am J Respir Crit Care Med* 2001;164:2147-2165.
- Chastre J, Fagon JY. Ventilator-associated pneumonia. *Am J Respir Crit Care Med* 2002;165:867-903.
- Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: a population health perspective. *Am J Respir Crit Care Med* 2002;165:1217-1239.
- Chan ED, Morales DV, Welsh CH, McDermott MT, Schwarz MI. Calcium deposition with or without bone formation in the lung. *Am J Respir Crit Care Med* 2002;165:1654-1669.
- Seymour JF, Presneill JJ. Pulmonary alveolar proteinosis: progress in the first 44 years. *Am J Respir Crit Care Med* 2002;166:215-235.
- Spiro SG, Porter JC. Lung cancer: where are we today? Current advances in staging and nonsurgical treatment. *Am J Respir Crit Care Med* 2002;166:1166-1196.
- O'Brien RJ, Nunn PP. The need for new drugs against tuberculosis: obstacles, opportunities, and next steps. *Am J Respir Crit Care Med* 2001;163:1055-1058.
- Saetta M, Turato G, Maestrelli P, Mapp CE, Fabbri LM. Cellular and structural bases of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2001;163:1304-1309.
- Britton J, Jarvis M, McNeill A, Bates C, Cuthbertson L, Godfrey C. Treating nicotine addiction: not a medical problem? *Am J Respir Crit Care Med* 2001;164:13-15.
- Gozal D, Gaultier C. Evolving concepts of the maturation of central pathways underlying the hypoxic ventilatory response. *Am J Respir Crit Care Med* 2001;164:325-329.
- Idell S. Anticoagulants for acute respiratory distress syndrome: can they work? *Am J Respir Crit Care Med* 2001;164:517-520.
- Mutlu GM, Garey KW, Robbins RA, Danziger LH, Rubinstein I. Collection and analysis of exhaled breath condensate in humans. *Am J Respir Crit Care Med* 2001;164:731-737.
- Kips JC, Pauwels RA. Long-acting inhaled β_2 agonist therapy in asthma. *Am J Respir Crit Care Med* 2001;164:923-932.
- Salvi SS, Babu KS, Holgate ST. Is asthma really due to a polarized T cell response toward a helper T cell type 2 phenotype? *Am J Respir Crit Care Med* 2001;164:1343-1346.
- Debigaré R, Côté CH, Maltais F. Peripheral muscle wasting in chronic obstructive pulmonary disease: clinical relevance and mechanisms. *Am J Respir Crit Care Med* 2001;164:1712-1717.
- Minter KR, Gladwin MT. Pulmonary complications of sickle cell anemia: a need for increased recognition, treatment, and research. *Am J Respir Crit Care Med* 2001;164:2016-2019.
- Palmer LJ, Silverman ES, Weiss ST, Drazen JM. Pharmacogenetics of asthma. *Am J Respir Crit Care Med* 2002;165:861-866.
- Hoepfer MM, Galié N, Simonneau G, Rubin LJ. New treatments for pulmonary arterial hypertension. *Am J Respir Crit Care Med* 2002;165:1209-1216.
- Hanania NA, Sharafkhaneh A, Barber R, Dickey BF. β -agonist intrinsic efficacy: measurement and clinical significance. *Am J Respir Crit Care Med* 2002;165:1353-1358.
- Suki B. Fluctuations and power laws in pulmonary physiology. *Am J Respir Crit Care Med* 2002;166:133-137.
- Estenne M, Hertz MI. Bronchiolitis obliterans after human lung transplantation. *Am J Respir Crit Care Med* 2002;166:440-444.
- Lazarevic V, Flynn J. CD8⁺ T cells in tuberculosis. *Am J Respir Crit Care Med* 2002;166:1116-1121.
- Munford RS, Pugin J. Normal responses to injury prevent systemic inflammation and can be immunosuppressive. *Am J Respir Crit Care Med* 2001;163:316-321.
- Luce JM, Lemaire F. Two transatlantic viewpoints on an ethical quandary. *Am J Respir Crit Care Med* 2001;163:818-821.
- Tobin MJ, Jubran A, Laghi F. Patient-ventilator interaction. *Am J Respir Crit Care Med* 2001;163:1059-1063.
- Frossard JL, Hadengue A, Pastor CM. New serum markers for the detection of severe acute pancreatitis in humans. *Am J Respir Crit Care Med* 2001;164:162-170.
- Freeman BD, Danner RL, Banks SM, Natanson C. Safeguarding patients in clinical trials with high mortality rates. *Am J Respir Crit Care Med* 2001;164:190-192.
- Luce JM, Rubenfeld GD. Can health care costs be reduced by limiting intensive care at the end of life? *Am J Respir Crit Care Med* 2002;165:750-754.
- Rouby JJ, Lu Q, Goldstein I. Selecting the right level of positive end-expiratory pressure in patients with acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2002;165:1182-1186.
- Hubmayr RD. Perspective on lung injury and recruitment: a skeptical look at the opening and collapse story. *Am J Respir Crit Care Med* 2002;165:1647-1653.
- Michaud S, Suzuki S, Harbarth S. Effect of design-related bias in studies of diagnostic tests for ventilator-associated pneumonia. *Am J Respir Crit Care Med* 2002;166:1320-1325.
- Eichacker PQ, Gerstenberger EP, Banks SM, Cui X, Natanson C. Meta-

- analysis of acute lung injury and acute respiratory distress syndrome trials testing low tidal volumes. *Am J Respir Crit Care Med* 2002;166:1510-1514.
41. Gentilello LM, Pierson DJ. Trauma critical care. *Am J Respir Crit Care Med* 2001;163:604-607.
 42. Campbell LA, Klocke RA. Implications for the pregnant patient. *Am J Respir Crit Care Med* 2001;163:1051-1054.
 43. Shenker Y, Skatrud JB. Adrenal insufficiency in critically ill patients. *Am J Respir Crit Care Med* 2001;163:1520-1523.
 44. Provencio JJ, Bleck TP, Connors AF Jr. Critical care neurology. *Am J Respir Crit Care Med* 2001;164:341-345.
 45. Schulman SP, Fessler HE. Management of acute coronary syndromes. *Am J Respir Crit Care Med* 2001;164:917-922.
 46. Boord JB, Graber AL, Christman JW, Powers AC. Practical management of diabetes in critically ill patients. *Am J Respir Crit Care Med* 2001;164:1763-1767.
 47. Poppas A, Rounds S. Congestive heart failure. *Am J Respir Crit Care Med* 2002;165:4-8.
 48. Block CA, Manning HL. Prevention of acute renal failure in the critically ill. *Am J Respir Crit Care Med* 2002;165:320-324.
 49. Zwischenberger JB, Savage C, Bidani A. Surgical aspects of esophageal disease: perforation and caustic injury. *Am J Respir Crit Care Med* 2002;165:1037-1040.
 50. Saint S, Savel RH, Matthay MA. Enhancing the safety of critically ill patients by reducing urinary and central venous catheter-related infections. *Am J Respir Crit Care Med* 2002;165:1475-1479.
 51. Chu J, Wang RY, Hill NS. Update in clinical toxicology. *Am J Respir Crit Care Med* 2002;166:9-15.
 52. Shah PB, Lilly CM. Interventional therapy for coronary artery disease. *Am J Respir Crit Care Med* 2002;166:791-796.
 53. Schlesinger PA, Leatherman JW. Rheumatology. *Am J Respir Crit Care Med* 2002;166:1161-1165.
 54. Douglas NJ. "Why am I sleepy?": sorting the somnolent. *Am J Respir Crit Care Med* 2001;163:1310-1313.
 55. Burman WJ, Jones BE. Treatment of HIV-related tuberculosis in the era of effective antiretroviral therapy. *Am J Respir Crit Care Med* 2001;164:7-12.
 56. Schluger NW. Changing approaches to the diagnosis of tuberculosis. *Am J Respir Crit Care Med* 2001;164:2020-2024.
 57. George CF, Findley LJ, Hack MA, Douglas MR. Across-country viewpoints on sleepiness during driving. *Am J Respir Crit Care Med* 2002;165:746-749.
 58. Messerole E, Peine P, Wittkopp S, Marini JJ, Albert RK. The pragmatics of prone positioning. *Am J Respir Crit Care Med* 2002;165:1359-1363.
 59. Irwin RS, Madison JM. The persistently troublesome cough. *Am J Respir Crit Care Med* 2002;165:1469-1474.
 60. Afessa B, Tefferi A, Litzow MR, Krowka MJ, Wylam ME, Peters SG. Diffuse alveolar hemorrhage in hematopoietic stem cell transplant recipients. *Am J Respir Crit Care Med* 2002;166:641-645.
 61. Bohn D. Congenital diaphragmatic hernia. *Am J Respir Crit Care Med* 2002;166:911-915.
 62. Kress JP, Pohlman AS, Hall JB. Sedation and analgesia in the intensive care unit. *Am J Respir Crit Care Med* 2002;166:1024-1028.
 63. Vieillard-Baron A, Prin S, Chergui K, Dubourg O, Jardin F. Echo-Doppler demonstration of acute cor pulmonale at the bedside in the medical intensive care unit. *Am J Respir Crit Care Med* 2002;166:1310-1319.
 64. Riley RL. What nobody needs to know about airborne infection. *Am J Respir Crit Care Med* 2001;163:7-8.
 65. Weibel ER. Why measure lung structure? *Am J Respir Crit Care Med* 2001;163:314-315.
 66. Petty TL. In the cards was ARDS: how we discovered the acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2001;163:602-603.
 67. Bryan AC. The oscillations of HFO. *Am J Respir Crit Care Med* 2001;163:816-817.
 68. Fairley HB. Ventilating the acutely injured lung. *Am J Respir Crit Care Med* 2001;163:1049-1050.
 69. Bates DV. Enter the stranger: the story of xenon. *Am J Respir Crit Care Med* 2001;163:1302-1303.
 70. Tenney SM. On the merit of making comparisons. *Am J Respir Crit Care Med* 2001;164:5-6.
 71. Widdicombe J. The race to explore the pathway to cough: who won the silver medal? *Am J Respir Crit Care Med* 2001;164:729-730.
 72. Guz A. Hering and Breuer revisited in humans: an invasive study before the days of ethics committees. *Am J Respir Crit Care Med* 2001;164:1110-1111.
 73. Becklake MR. When the chest X-ray does not tell the whole story: a tale of miners, selection bias, and the healthy worker effect. *Am J Respir Crit Care Med* 2001;164:1761-1762.
 74. Rochester DF. Energy expenditure of the diaphragm or "he thinks the diaphragm is the heart". *Am J Respir Crit Care Med* 2001;164:2145-2146.
 75. Wasserman K. Exercise gas exchange, breath-by-breath. *Am J Respir Crit Care Med* 2002;165:325-326.
 76. Hyde RW. Cowbird research and measuring pulsatile diffusing capacity. *Am J Respir Crit Care Med* 2002;165:755-756.
 77. Sackner MA. Serendipity times two: fiberoptic bronchoscopy becomes a medical procedure. *Am J Respir Crit Care Med* 2002;166:639-640.
 78. Reeves JT. High adventure in pulmonary hypertension: acute and chronic hypoxia are not the same. *Am J Respir Crit Care Med* 2002;166:1537-1538.
 79. Albert RK. The buck stops here. *Am J Respir Crit Care Med* 2001;163:9-10.
 80. Cooper RA. The COMPACCS Study: questions left unanswered: The Committee on Manpower for Pulmonary and Critical Care Societies. *Am J Respir Crit Care Med* 2001;163:10-11.
 81. Benatar SR. Respiratory health in a globalizing world. *Am J Respir Crit Care Med* 2001;163:1064-1067.
 82. Pack AI. Rip Van Winkle: will academic pulmonary programs ever wake up to sleep? *Am J Respir Crit Care Med* 2001;164:2143-2144.
 83. Hoppin FG Jr. How I review an original scientific article. *Am J Respir Crit Care Med* 2002;166:1019-1023.
 84. Davidoff F. Annals now and then. *Ann Intern Med* 1996;124:67-68.
 85. Bailar JC III. The promise and problems of meta-analysis. *N Engl J Med* 1997;337:559-561.
 86. Gregoire G, Derderian F, Le Lorier J. Selecting the language of the publications included in a meta-analysis: is there a Tower of Babel bias? *J Clin Epidemiol* 1995;48:159-163.
 87. Cochrane Injuries Group Albumin Reviewers. Human albumin administration in critically ill patients: systematic review of randomised controlled trials. *BMJ* 1998;317:235-240.
 88. Tobin MJ. Rigor of peer review and the standing of a journal. *Am J Respir Crit Care Med* 2002;166:1013-1014.
 89. Mulrow CD. The medical review article: state of the science. *Ann Intern Med* 1987;106:485-488.
 90. Cook DJ, Mulrow CD, Haynes RB. Systematic reviews: synthesis of best evidence for clinical decisions. *Ann Intern Med* 1997;126:376-380.
 91. Mulrow CD, Cook DJ, Davidoff F. Systematic reviews: critical links in the great chain of evidence. *Ann Intern Med* 1997;126:389-391.
 92. Kass EH. Reviewing reviews. In: Warren KS, editor. Coping with the biomedical literature: a primer for the scientist and the clinician. New York: Praeger; 1981. p. 79-91.
 93. Kuhn TS. The structure of scientific revolutions. Chicago: University of Chicago Press; 1962.
 94. Stigler GJ. The nature and role of originality in scientific progress. In: Stigler GJ, editor. Essays in the history of economics. Chicago: University of Chicago Press; 1965. p. 1-15.

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