**Name of journal: *World Journal of Anesthesiology***

**Manuscript NO: 45644**

**Manuscript type: OPINION REVIEW**

**Healthcare delivery cost and anesthesiologists: time to have a greater role and responsibility**

Karim HMR. Healthcare delivery cost and anesthesiologists

**Habib Md Reazaul Karim**

**Habib Md Reazaul Karim,** Department of Anaesthesiology and Critical Care, All India Institute of Medical Sciences, Raipur 492099, India

**ORCID number:** Habib Md Reazaul Karim (0000-0002-6632-0491).

**Author contributions:** Karim HMR performed the literature search, manuscript preparation, and editing.

**Conflict-of-interest statement:** No potential conflicts of interest relevant to this article were reported.

**Open-Access:** This is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non-Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

**Manuscript source:** Unsolicited manuscript

**Corresponding author: Habib Md Reazaul Karim, MBBS, MD, DNB, Assistant Professor,** Department of Anaesthesiology and Critical Care, All India Institute of Medical Sciences, Great Eastern Road, Raipur 492099, India. drhabibkarim@gmail.com

**Telephone:** +91-96-12372585

**Received:** January 9, 2019

**Peer-review started:** January 9, 2019

**First decision:** April 11, 2019

**Revised:** April 16, 2019

**Accepted:** June 17, 2019

**Article in press:**

**Published online:**

**Abstract**

With the advancement of technology and health sciences, health care delivery costs are steadily increasing. This affects both households and governments. Unfortunately, the present truth is that health has become an essential but unaffordable commodity. This is very concerning. Quality, up-to-date, cost-effective health care delivery is one of the prime objectives, and focuses on administration and health care authority. As the per capita spent on health from public/government funds is very poor in developing countries, the responsibility of cost-effective health care delivery falls primarily on the shoulder of the treating physicians. Anesthesiologists are becoming an indispensable part of health care delivery, having a diverse role in the emergency, critical care, pain, and perioperative care of patients. As the population ages, the need for surgical care is also increasing. Therefore, the anesthesiologist can also play a more significant role in delivering cost-effective health care, and minimize the cost without affecting the quality. This brief narrative review analyzes the current practice of anesthesiologists in two prime areas in the context of cost-savings: preoperative investigation and low/minimal flow anesthesia.

**Keywords:** Health expenditures; Cost control; Anesthesiologists; Anesthesia

**© The Author(s) 2019.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** Health care costs are escalating worldwide, affecting both governments and households. The need for surgery and interventional procedures are also steadily increasing. This has led to the increased requirement of clinical services from anesthesiologists. Therefore, anesthesiologists can also play an important role in cost containment. Two of the significant areas where cost reduction is possible are preoperative tests and the use of low and minimal flow anesthesia. However, a few factors may act as a hindrance to clinical practice. This opinion review paper discusses these issues and the possible remedial steps for providing cost-effective, quality healthcare, especially in developing countries.

Karim HMR. Healthcare delivery cost and anesthesiologists: time to have a greater role and responsibility. *World J Anesthesiol* 2019; In press

**INTRODUCTION**

Rising health care cost is becoming a more significant obstacle in both advanced and developed countries like the United States[1,2]. It affects both households and governments. Cost-effective health care delivery is not only the responsibility of the government, but also hospital administrations and health care providers. The responsibility of hospital administrations and health care providers takes a special position in developing and third world countries where the public sector expenditure to health is very minimal[3,4]. The active role of anesthesiologists in health care delivery is increasing, and encroachment of more extensive areas is happening day by day. Perioperative care is one of the most important areas of such a duty. A total of 28%-32% of the global disease burden comes from surgical diseases[5]. With an aging population, the requirement of surgical procedures has been predicted to increase by 14%-47%[6]. These data clearly show the current increased need of anesthesia and surgery services, with ample opportunity to fulfill the responsibility.

One of the components of surgical care expenditures is investigations. Inappropriate or unnecessary tests and procedures recommended by physicians, as well as frequent requests from patients, leads to wasteful health care spending[7]. Preoperative investigation, mainly routine preoperative investigation, is one such entity. The expenditure incurred by the government/administration or patient varies widely depending on the type of surgery and perioperative care. A study conducted in India has shown that the average expenditure by a patient for routine preoperative investigations, even in a subsidized, public sector hospital, is 1029 Indian rupees[8]. Spending on preoperative testing for even cataract surgery in Canada is $40 per surgery[9]. As the lion’s share of health care delivery is from the private sector where the charges are not subsidized, the prices are expected to be very high in these situations. Studies have shown that routine preoperative investigation has very little to no effect on patient outcome[10,11], and there is a negative perception of routine investigations[12,13].

Anesthesiologists actively decide the intraoperative management of anesthesia maintenance. Nevertheless, many of the cases can be, and are being safely performed under regional anesthesia; a good number of patients still require general anesthesia (GA) for conducting surgery or interventions. Balanced, inhalational anesthetic-based GA is the most commonly practiced GA technique, and in cases other than total intravenous anesthesia, the maintenance phase of GA is usually managed with volatile anesthetics[14]. The consumption of volatile anesthetics directly depends on the fresh gas flow (FGF) used. It has been found that using low/minimal flow anesthesia reduces the cost of anesthesia[15]. Therefore, the anesthesiologists' decision and practice affects the cost of care. Although anesthesiologists are involved in multiple aspects of the clinical practice, this brief narrative review analyzes the current practices of anesthesiologists in the context of preoperative investigation and low/minimal flow anesthesia.

**CURRENT PRACTICE OF PREOPERATIVE TESTING AND EVIDENCE**

The American Society of Anesthesiologists and the National Institute of Health and Clinical Excellence (NICE) recommends against the routine use of preoperative investigations[12,13]. However, despite the current negative recommendations, the routine preoperative investigation practices are still very prevalent[16,17]. A study analyzing the impact of abnormal test results from routine preoperative investigations found that the implications of abnormal test results in changing anesthetic management is very minimal[8]. A similar study conducted in patients over 60 years old also found an insignificant impact in most of the cases[18]. Another study evaluating the effect of preoperative routine blood investigations in elderly patients who underwent oncosurgical procedures found that it did not predict the postoperative complication rate and did not influence anesthetic management[19]. Another study analyzing the usefulness of routine preoperative testing in developing countries found that abnormal tests were very much prevalent, but only 0-8.3% of the test results led to management changes[20]. Analysis of routine preoperative tests from the National Surgical Quality databases found that the postoperative outcomes were not associated with either testing or abnormal results in patients undergoing low-risk ambulatory surgeries[21]. A systematic review evaluating the effectiveness of non-cardiac preoperative testing in non-cardiac elective surgery did not find convincing evidence that preoperative testing was beneficial in healthy adults undergoing non-cardiac surgery[22]. However, abnormal test results in co-morbid patients were significantly and more frequently changing the anesthetic management compared to non-co-morbid patients in some disease-specific tests[23]. The systematic review also indicated that testing should be based on the specific pathology (co-morbidity/disease-specific).

**CURRENT PRACTICE OF LOW AND MINIMAL FLOW ANESTHESIA AND EVIDENCE**

The use of low and minimal flow anesthesia has many advantages, including reduced volatile anesthetic agent consumption[15]. With the advancement of anesthesia workstations and monitoring modalities, the precise management of carrier gases and volatile anesthetics has become a reality. The relatively new volatile anesthetic agents are costlier, yet their use becomes economically acceptable when used with lower FGF[24]. A study has shown that desflurane-based anesthesia is costlier[25]. However, a study has shown that the use of minimal flow anesthesia can even reduce the cost of desflurane-based anesthesia to a great extent, and can also be economically viable for a long surgery duration[26]. A recent study has shown that the cost incurred for minimal flow anesthesia (FGF 500 mL/min) using sevoflurane was lower than low flow anesthesia (FGF 1L/min) for 1 MAChour of anesthesia[27]. The study also found that using sevoflurane for both induction and maintenance was more cost-effective[27]. Another study found that automated control of end-tidal sevoflurane with 500 mL/min FGF was very cost-effective when compared with conventional flow technique[28].

Similarly, real-time decision support that notified of excessive FGF was also found to be effective in delivering more cost-effective anesthesia[29]. This indicates that the scope for economical use and practice of the newer volatile anesthetic agents are there. Unfortunately, the practice of low and minimal flow anesthesia is still not universal. Two recent surveys showed that the acceptance of low flow anesthesia is still sparse, and that minimal flow anesthesia or even an FGF < 600 mL/min is far less[30,31]. Surveys also showed the lack of relatively advanced monitoring required for practicing low and minimal flow anesthesia[30,32]. Low flow anesthesia until now has remained an under-utilized yet effective and sustainable anesthesia practice modality[33].

**LIMITATIONS FOR CLINICAL PRACTICES AND POSSIBLE REMEDIES**

While anesthesia maintenance is in the hands of the anesthesiologist, preoperative investigations are not. Moreover, practicing minimal and low flow anesthesia usually requires advanced anesthesia workstations, agent monitoring, inspired and expired gas concentrations, *etc*. The Association of Anaesthesiologists of Great Britain and Ireland recommends for the routine use of anesthesia gas monitoring when using volatile anesthetic-based anesthesia as a standard[34]. However, the availability of such advanced and costly modalities are not universal, especially in developing and third world countries. A recent survey conducted in India has shown that a good number of practicing anesthesiologists are using Boyle’s machine. Not having the minimum alveolar concentration monitoring facilities results in them mostly practicing conventional or high flow anesthesia[30]. Similarly, guidelines and recommendations could not take out the apprehensions of medico-legal aspects, and harassment from the mind of practicing anesthesiologists. A survey has shown that even after acknowledging the negative recommendations and agreeing to abandon the routine preoperative testing, this was not possible, as many institutes have a protocol that is in favor of a battery of tests or so-called ‘routine testing[16].

Prospective studies have also shown that most patients attend the pre-anesthetic assessment clinic with all of the possible tests performed by the surgical team[17]. Thus, it is imperative to have an interchange of thoughts between surgeons and anesthesiologists regarding the indications of different preoperative tests, especially the need for patient and surgery-specific tests. This is important not only to optimize the utilization of preoperative tests by surgeons, but also to increase team efficiency towards the cost-effective health care delivery by reducing unnecessary preoperative laboratory tests. Therefore, communication with surgeons must be a priority for anesthesiologists as a means of reducing these expenditures.

Similarly, anesthesiologists should also take into account the cost of volatile anesthetic agent use. Although desflurane can be cost-effective for long-duration surgery, it may not be the right choice for short procedures, even with low or minimal flow anesthesia[26]. This is because even low and minimal flow anesthesia needs high FGF in the initial phase of anesthesia. In such a situation, cheaper agents like Isoflurane are likely to be the right choice for cost reduction.

**WHAT IS THEIR ROLE BEYOND CLINICAL PRACTICE?**

By now, it is clear to us that the anesthesiologist does have a more significant role and responsibility to play in reducing the surgical care cost. However, their hands are bound to some extent by certain limitations like the administrative decision, equipment availability, and interdepartmental categories, especially anesthesia and surgical team co-cooperativeness. Therefore, only concentrating on the clinical practice aspect cannot provide most of the results in terms of cost-reduction. Anesthesiologists and anesthesia societies need to take a step towards formulating practice guidelines and protocols at the local hospital, regional, and national levels. They should approach the administration, convince them with concrete evidence, and discuss the pros and cons of having a better evidence-based protocol. An article welcoming the updated 2016 NICE preoperative test guideline suggested three-tier roles at the institute/hospital level, at the professional bodies/organization/societies level, and at the national health authority level, for maximum utilization of the recommendations[35]. With the advancement of electronic health record management and information technology, anesthesiologists and surgeons can work jointly to increase the coordination, which is likely to reduce the prescription of unnecessary preoperative testing[36]. However, an ongoing study will give us a better idea of this aspect in the future[37].

**CONCLUSION**

The anesthesiologist can play a vital role in reducing the cost of health care delivery, especially in surgical care. This requires better and greater implementation of low and minimal flow anesthesia, while discarding routine preoperative testing and adopting patient and surgery-specific preoperative investigations. However, limitations in clinical practice and applications exist, so this involvement in protocol formation and administration are therefore very essential. Governments/administrations should also take on anesthesiologists and/or anesthesia societies, while formulating plans and protocols for the greater interests of the patient and national economy.

**REFERENCES**

1 **Papanicolas I**, Woskie LR, Jha AK. Health Care Spending in the United States and Other High-Income Countries. *JAMA* 2018; **319**: 1024-1039 [PMID: 29536101 DOI: 10.1001/jama.2018.1150]

2 **Squires DA**. Explaining high health care spending in the United States: an international comparison of supply, utilization, prices, and quality. *Issue Brief (Commonw Fund)* 2012; **10**: 1-14 [PMID: 22619775]

3 **Global Burden of Disease Health Financing Collaborator Network**. Future and potential spending on health 2015-40: development assistance for health, and government, prepaid private, and out-of-pocket health spending in 184 countries. *Lancet* 2017; **389**: 2005-2030 [PMID: 28433260 DOI: 10.1016/S0140-6736(17)30873-5]

4 **Xu K,** Saksena P, Holly A. The Determinants of Health Expenditure: A Country-Level Panel Data Analysis. Working Paper of the Results for Development Institute (R4D): World Health Organization 2011. [cited 2019 Jan 7] Available from: https://www.who.int/health\_financing/documents/report\_en\_11\_deter-he.pdf

5 Global Surgery Anaesthesia Statistics. German Global Surgery Association/ Program in Global Surgery and Social Change at Harvard Medical School/The G4 Alliance. [cited 2019 Jan 7] Available from: https://static1.squarespace.com/static/5435b2b9e4b0e1fd29fa9d26/t/5aa2b3374192023932fb6690/1520612157567/Surgical%26AnaesthesiaDataReport.pdf

6 **Etzioni DA**, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. *Ann Surg* 2003; **238**: 170-177 [PMID: 12894008 DOI: 10.1097/01.SLA.0000081085.98792.3d]

7 **Mack M**. What Drives Rising Health-Care Costs? Government Finance Review 2016 Aug [cited 2019 Jan 7] Available from: https://www.gfoa.org/sites/default/files/GFR081626.pdf

8 **Reazaul Karim HM**, Prakash A, Sahoo SK, Narayan A, Vijayan V. Abnormal routine pre-operative test results and their impact on anaesthetic management: An observational study. *Indian J Anaesth* 2018; **62**: 23-28 [PMID: 29416147 DOI: 10.4103/ija.IJA\_223\_17]

9 **Jastrzebski A**, Villafranca A, Sethi S, Bellan L; Misericordia Health Centre Cataract Surgery Working Group. Safety and comparative costs of preoperative assessments for cataract surgery: traditional mandatory assessment versus a novel graded assessment system. *Can J Anaesth* 2016; **63**: 842-850 [PMID: 26943645 DOI: 10.1007/s12630-016-0626-x]

10 **Dzankic S**, Pastor D, Gonzalez C, Leung JM. The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. *Anesth Analg* 2001; **93**: 301-308, 2nd contents page [PMID: 11473849 DOI: 10.1097/00000539-200108000-00013]

11 **Alboim C**, Kliemann RB, Soares LE, Ferreira MM, Polanczyk CA, Biolo A. The impact of preoperative evaluation on perioperative events in patients undergoing cataract surgery: a cohort study. *Eye* (Lond) 2016; **30**: 1614-1622 [PMID: 27636228 DOI: 10.1038/eye.2016.203]

12 **Committee on Standards and Practice Parameters**, Apfelbaum JL, Connis RT, Nickinovich DG; American Society of Anesthesiologists Task Force on Preanesthesia Evaluation, Pasternak LR, Arens JF, Caplan RA, Connis RT, Fleisher LA, Flowerdew R, Gold BS, Mayhew JF, Nickinovich DG, Rice LJ, Roizen MF, Twersky RS. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology* 2012; **116**: 522-538 [PMID: 22273990 DOI: 10.1097/ALN.0b013e31823c1067]

13 **National Guideline Centre (UK)**. Preoperative Tests (Update): Routine Preoperative Tests for Elective Surgery. 2016 [PMID: 27077168]

14 **Fox AJ**, Rowbotham DJ. Anaesthesia. *BMJ* 1999; **319**: 557-560 [PMID: 10463900 DOI: 10.1136/bmj.319.7209.557]

15 **Brattwall M**, Warrén-Stomberg M, Hesselvik F, Jakobsson J. Brief review: theory and practice of minimal fresh gas flow anesthesia. *Can J Anaesth* 2012; **59**: 785-797 [PMID: 22653840 DOI: 10.1007/s12630-012-9736-2]

16 **Karim HMR**. Practice and reasons for routine pre-operative investigations among anaesthesiologists and surgeons: An online survey. *Indian J Anaesth* 2017; **61**: 933-935 [PMID: 29217861 DOI: 10.4103/ija.IJA\_92\_17]

17 **Karim HM**, Yunus M, Bhattacharyya P. An observational cohort study on pre-operative investigations and referrals: How far are we following recommendations? *Indian J Anaesth* 2016; **60**: 552-559 [PMID: 27601737 DOI: 10.4103/0019-5049.187783]

18 **Reazaul Karim HM,** Sahoo SK, Prakash A, Rajaram N, Kumar S, Narayan A. Abnormal routine preoperative test results and their perioperative anesthetic impact in patients aged 60 years and more: An observational study. *Indian Anaesth Forum* 2018; **19**: 6-10 [DOI: 10.4103/TheIAForum.TheIAForum\_41\_17]

19 **Ramesh B**, Pillai VS, Koshy RC, Jagathnath Krishna KM. Role of preoperative investigations in elderly patients undergoing oncosurgical procedures - A retrospective review audit. *J Anaesthesiol Clin Pharmacol* 2018; **34**: 535-539 [PMID: 30774237 DOI: 10.4103/joacp.JOACP\_147\_17]

20 **Bordes J**, Cungi PJ, Savoie PH, Bonnet S, Kaiser E. Usefulness of routine preoperative testing in a developing country: a prospective study. *Pan Afr Med J* 2015; **21**: 94 [PMID: 26516395 DOI: 10.11604/pamj.2015.21.94.5860]

21 **Benarroch-Gampel J**, Sheffield KM, Duncan CB, Brown KM, Han Y, Townsend CM Jr, Riall TS. Preoperative laboratory testing in patients undergoing elective, low-risk ambulatory surgery. *Ann Surg* 2012; **256**: 518-528 [PMID: 22868362 DOI: 10.1097/SLA.0b013e318265bcdb]

22 **Johansson T**, Fritsch G, Flamm M, Hansbauer B, Bachofner N, Mann E, Bock M, Sönnichsen AC. Effectiveness of non-cardiac preoperative testing in non-cardiac elective surgery: a systematic review. *Br J Anaesth* 2013; **110**: 926-939 [PMID: 23578861 DOI: 10.1093/bja/aet071]

23 **Rajaram N**, Karim HMR, Prakash A, Sahoo SK, Dhar M, Narayan A. Prevalence and impact of abnormal routine pre-operative test results among elective surgical patients with or without co-morbidity: An observational comparative study. *Niger Postgrad Med J* 2018; **25**: 121-125 [PMID: 30027925 DOI: 10.4103/npmj.npmj\_34\_18]

24 **Eger EI 2nd**. Economic analysis and pharmaceutical policy: a consideration of the economics of the use of desflurane. *Anaesthesia* 1995; **50** Suppl: 45-48 [PMID: 7485918 DOI: 10.1111/j.1365-2044.1995.tb06190.x]

25 **Martelli A**. Costs optimization in anaesthesia. *Acta Biomed* 2015; **86**: 38-44 [PMID: 25948026]

26 **Karim HM,** Yunus M, Sailo L, Sangma SJ, Syiemiong N. Pharmacoeconomics of desflurane based minimal flow anesthesia for different durations of surgery. I*nt J Basic Clin Pharmacol* 2016; **5**: 2528-33 [DOI: 10.18203/2319-2003.ijbcp20164117]

27 **Tyagi A**, Venkateswaran V, Jain AK, Verma UC. Cost analysis of three techniques of administering sevoflurane. *Anesthesiol Res Pract* 2014; **2014**: 459432 [PMID: 25530758 DOI: 10.1155/2014/459432]

28 **Kandeela A,** Elmorshedia M, Abdallaa U, Abouelelaa M, Elsarrafa W, Sultan A, Abdelwahab M, Yassen AM. Automated control of end-tidal sevoflurane in living donor hepatectomy, a prospective, randomized, controlled study. *Egyptian J Anaesth* 2017; **33**: 233-237 [DOI: 10.1016/j.egja.2017.05.007]

29 **Nair BG**, Peterson GN, Neradilek MB, Newman SF, Huang EY, Schwid HA. Reducing wastage of inhalation anesthetics using real-time decision support to notify of excessive fresh gas flow. *Anesthesiology* 2013; **118**: 874-884 [PMID: 23442753 DOI: 10.1097/ALN.0b013e3182829de0]

30 **Kumar M**, Sinha M, Reazaul Karim HM, Panda CK, Singha SK. Practice Pattern of Fresh Gas Flow and Volatile Agent Choices among Anesthesiologists Working in Different Indian Hospitals: An Online Survey. *Anesth Essays Res* 2018; **12**: 907-913 [PMID: 30662129 DOI: 10.4103/aer.AER\_164\_18]

31 **Amma RO**, Ravindran S, Koshy RC, Jagathnath Krishna KM. A survey on the use of low flow anaesthesia and the choice of inhalational anaesthetic agents among anaesthesiologists of India. *Indian J Anaesth* 2016; **60**: 751-756 [PMID: 27761039 DOI: 10.4103/0019-5049.191692]

32 **Mahajan V,** Gupta S. A Questionnaire Survey on use of Low Flow Anesthesia by Anesthesiologists. *JMSCR* 2017; **5**: 32253-32257 [DOI: 10.18535/jmscr/v5i12.157]

33 **Upadya M**, Saneesh PJ. Low-flow anaesthesia - underused mode towards "sustainable anaesthesia". *Indian J Anaesth* 2018; **62**: 166-172 [PMID: 29643549 DOI: 10.4103/ija.IJA\_413\_17]

34 **Checketts MR**, Alladi R, Ferguson K, Gemmell L, Handy JM, Klein AA, Love NJ, Misra U, Morris C, Nathanson MH, Rodney GE, Verma R, Pandit JJ; Association of Anaesthetists of Great Britain and Ireland. Recommendations for standards of monitoring during anaesthesia and recovery 2015: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia* 2016; **71**: 85-93 [PMID: 26582586 DOI: 10.1111/anae.13316]

35 **Yunus M,** Karim HM, Dey S. New Guidelines on preoperative tests. *Arch Med Review J* 2017; **26**: 232-237

36 **Karim HMR**. Adopting Information Management Based Joint Preoperative Assessment and Risk Stratification Model to Save Surgical Care Cost. *J Anesth Surg* 2017; **4**: 7-8 [DOI: 10.15436/2377-1364.17.059]

37 **Karim HMR**. Information technology based joint preoperative assessment, risk stratification and its impact on patient management, perioperative outcome and cost. [Accessed 2018 Nov 27]. Clinical Trials Registry India [Internet]. New Delhi: database publisher (India). Available from: http://ctri.nic.in/Clinicaltrials/pmaindet2.php?trialid=22288&EncHid=&userName=CTRI/2018/11/016441 ClinicalTrials.gov Identifier: CTRI/2018/11/016441

**P-Reviewer:** Kvolik S

**S-Editor:** Cui LJ **L-Editor:** Filipodia **E-Editor:**

**Specialty type:** Anesthesiology

**Country of origin:** India

**Peer-review report classification**

Grade A (Excellent): 0

Grade B (Very good): 0

Grade C (Good): C

Grade D (Fair): 0

Grade E (Poor): 0