Cost analyses approaches in medical education: there are no simple solutions

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CONTEXT Medical education is expensive. Although we have made progress in working out 'what works' in medical education, there are few data on whether medical education offers value relative to cost. Research into cost and value in medical education is beset by problems. One of the major problems is the lack of clear definitions for many of the terms commonly used. Phrases such as cost-effectiveness analysis, cost-benefit analysis, cost-utility analysis and cost-feasibility analysis are used without authors explaining to readers what they mean (and sometimes without authors themselves understanding what they mean). Sometimes such terms are used interchangeably and sometimes they are used as rhetorical devices without any real evidence that backs up such rhetoric as to the cost-effectiveness or otherwise of educational interventions. The frequent misuse of these terms is surprising considering the importance of the topics under consideration and the need for precision in many aspects of medical education.

METHODS Here we define commonly used terms in cost analyses and give examples of their usage in the context of medical education.

CONCLUSIONS Cost-effectiveness analysis refers to the evaluation of two or more alternative educational approaches or interventions according to their costs and their effects in producing a certain outcome. Cost-benefit analysis refers to 'the evaluation of alternatives according to their costs and benefits when each is measured in monetary terms'. Cost-utility analysis is the examination of two or more alternatives according to their cost and their utility. In this context, utility means the satisfaction among individuals as a result of one or more outcome or the perceived value of the expected outcomes to a particular constituency. Cost-feasibility analysis involves simply measuring the cost of a proposed intervention in order to decide whether it is feasible.

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INTRODUCTION

Medical education is expensive. In estimating the cost of medical education we must take into account the costs of undergraduate education, postgraduate education and continuing professional development of doctors, nurses and allied health care professionals. The annual global spend on medical education will probably exceed £63 billion.[1] It is important to know whether this spend represents value relative to cost. There has been growing interest in the effectiveness of medical education over the past 30 years. A number of journals that feature research into various approaches and innovations in medical education have sprung up and these journals are currently thriving.[2] Different strands of research have examined the effectiveness, utility and acceptability of different forms of medical education. More recently there has been growing interest in cost and value in medical education. A number of articles have examined the cost and value of various educational approaches,[3–7] even though empirical study remains important.

However, research into cost and value in medical education is beset by problems.[8] First there is the issue of cost. Most educational interventions are not costed and most that are costed are not costed properly (for example, certain indirect costs are often missed). Recent attempts have been made to remedy this problem, but still much works needs to be done.[9,10] Second there is the issue of what constitutes effectiveness, utility or acceptability in medical education. Medical education is a complex phenomenon and not easily measured by instruments that we might use to measure the effectiveness of a drug, for example.[11] Medical education research often requires more robust theoretical underpinning and research articles need to take into account this theory. Third, even though some work has been carried out into the cost and value of medical education, this research has been hampered by a lack of a clear understanding among both authors and readers of correct nomenclature in this field. Phrases such as cost-effectiveness analysis, cost-benefit analysis, cost-utility analysis and cost-feasibility analysis are used without authors explaining to readers what they mean (and sometimes it appears without the authors themselves understanding what they mean).[12] Sometimes such terms are used interchangeably and sometimes they are used as rhetorical devices without any real evidence that backs up such rhetoric as to the cost-effectiveness or otherwise of educational interventions.[13] The frequent misuse of terms such as cost-effectiveness, cost-benefit, cost-utility and cost-feasibility analyses is surprising considering the importance of this field and the need for precision. It is impossible to imagine a world where a new health care intervention is incorporated into practice without rigorously evaluated evidence as to its cost and value.[14] In medical education, over £63 billion is at stake, so we must be equally rigorous and precise. This is because the increasing cost of medical education can have important consequences. Medical student debt can have an effect on a student's choice of career,[15] resulting in some students choosing higher-earning specialties to repay their debt. This in turn can affect the cost of health care provision to patients and populations. The cost of education to the individual is important, but equally important is the cost to the payer. The public will only tolerate funds being spent on medical education when they know that such funding is delivering the maximum possible returns. The purpose of this paper is to define the terms used in cost analyses, describe them in detail, outline their advantages and disadvantages and give examples of where they can be used. This paper adapts established methods for cost measurement and analysis in education generally to medical education specifically.[12,16] The methods have been used to analyse the cost and associated value in junior school, high school and college education in the USA and elsewhere over many years. The purpose of the paper is not to suggest that one approach to cost analysis is better than the others – they all have a role depending on the exact circumstance and the question that is being asked.

COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis refers to the evaluation of two or more alternative approaches or interventions according to their costs and their effects in producing a certain outcome.[16] As no approach can be cost-effective in and of itself, cost-effectiveness analysis means that two or more approaches are being compared. It would therefore be incorrect to say that 'e-learning is cost-effective'; by contrast, it would be correct to say that 'an e-learning intervention is more or less cost-effective than an alternative intervention'.

Cost-effectiveness analyses have a number of inherent strengths. When used correctly, they can guide our educational decision making and enable us to choose an approach that will maximise effectiveness

or save costs. Costs saved can then be re-invested in another educational intervention.[16] Cost-effectiveness analyses are also easy to understand and, hence, can help non-experts comprehend the thinking behind educational decisions.

However, cost-effectiveness analyses also have a number of weaknesses and limitations. First, they cannot be used to compare interventions with different intended outcomes. So, a cost-effectiveness analysis cannot be used to compare investments in simulation designed to improve the communication skills of students with investments in simulation designed to improve the clinical skills of students. Second, they cannot be used to compare interventions that do not have a 'common measure of effectiveness that can be used to assess them'.[16] For example, you cannot compare the cost-effectiveness of an educational intervention to improve communication skills (the effectiveness of which is measured by students' performance on a checklist-derived score) with an educational intervention (the effectiveness of which is measured by students' performance on a global-rating scale-derived score).[17] Another weakness of cost-effectiveness analysis is that you must be absolutely sure that the effect on the outcome is caused by the intervention and not by another factor that has not been noticed or measured. This is not always straightforward and there are a number of possible impediments to establishing causality.[18] These include non-equivalence of groups, attrition, maturation, the effects of testing and regression to the mean.[19] A full description of all of these is beyond the scope of this paper.

A worked example of a cost-effectiveness analysis is as follows. This is a fictional example and is purely illustrative – as are all the worked examples shown. The examples are also highly simplified so as to make lessons learned as clear as possible.

Worked example: cost-effectiveness analysis

A medical school creates a printed educational resource that is designed to improve students' applied knowledge scores in their end of year examinations. It also creates an online educational resource that is designed to improve students' applied knowledge scores in their end of year examinations. The costs of both interventions and their effects on applied knowledge scores are outlined in Table 1.

From Table 1 you can see that the printed educational resource is more cost-effective. If you did not look at cost, you would be tempted to choose the online resource as it is more effective. You could still go for the online resource if effectiveness was all important and money less of an object. This is an important point, true of cost-effectiveness analysis and indeed all cost-analysis approaches: cost analyses can guide decision making, but they should not necessarily make the decisions for us. The result of any cost analysis (like any other analysis) is only one piece of a jigsaw to inform decision makers – who ultimately must make important decisions in a socio-political milieu where evidence can play a valuable role.[20]

COST-BENEFIT ANALYSIS

An alternative way of measuring the cost and value of medical education is to use a cost-benefit analysis.[21] A cost-benefit analysis is 'the evaluation of alternatives according to their costs and benefits when each is measured in monetary terms'.[16] Using cost-benefit analysis, it would be logical to choose the alternative that had the highest benefit to cost ratio.

Cost-benefit analyses have a number of strengths. They can enable us to discover if any particular intervention on its own has benefits (to society or to another constituency) that exceed its costs, and so is worth investing in (naturally it would be illogical to invest in an innovation where the cost of an innovation exceeded its benefits). Cost-benefit analyses also enable us to compare the costs and benefits of interventions with different outcomes. Finally, cost-benefit analyses enable us to compare the costs and benefits of widely differing types of intervention in

Table 1 Cost-effectiveness analysis

	Cost per student per year	Effect on applied knowledge score	Cost per unit of effectiveness
Printed educational resource	£2	+8	2/8 = 0.25
Online educational resource	£4	+10	4/10 = 0.40

completely different areas (for example, the cost benefit of investing in assessment as compared with investing in evaluation). This makes cost-benefit analysis useful to decision makers in the real world who often have to choose between alternatives from which it is difficult to draw natural comparisons.

However, there are also disadvantages to using cost-benefit analyses in medical education. Cost-benefit analyses rely entirely on our ability to measure costs and benefits in monetary terms. This is not always possible to do. For example, how does one measure improved communication skills in graduate doctors in monetary terms? Cost-benefit analyses should therefore only be used when it is possible to measure benefits in monetary terms (usually the value in the competitive marketplace) or at the very least when it is possible to measure all the important benefits in monetary terms or when those benefits that cannot be converted into monetary terms can be shown to be similar among alternatives. As with cost-effectiveness analysis, the validity of the results of cost-benefit analyses relies on our ability to be sure that the benefit observed is caused by the intervention and not by other factors.

Worked example: cost-benefit analysis

A hospital sets up a multimodal risk management programme to improve the experiences of patients. The different interventions put in place include simulation-based education, communication skills teaching, team-based learning and quality improvement education. The costs, outcomes, total benefits and net benefits are outlined in Table 2.

From Table 2 you can see that the total benefit of the simulation-based education was less than the cost of the intervention. For all the other interventions, the cost of the intervention was less than the benefits achieved. The total net benefit was greatest for the team-based learning intervention. However, the quality improvement education prevented most medical accidents. Here again the data are useful and can inform decision making – but it need not dictate decision making. For some institutions it may be most important to prevent as many medical accidents as possible (for human reasons) regardless of the cost. Due to budgetary restraints, other health care systems and the institutions within them may have to make difficult rationing decisions.[22]

COST-UTILITY ANALYSIS

Cost-utility analysis is the examination of two or more alternatives according to their cost and their utility.[23] In this context, utility means the satisfaction among individuals as a result of one or more outcome or the perceived value of the expected outcomes to a particular constituency. Data on user satisfaction can be derived in a number of ways – such as by analysing the results of questionnaires or interviews. Cost-utility analysis is closely related to cost-effectiveness analysis. However, the key difference is that cost-effectiveness analysis must use a single measure of effectiveness, whereas cost-utility analysis enables researchers to amalgamate many different measures on effectiveness into a single measure of utility. Following this analysis the educational decision maker should logically choose interventions that deliver the highest level of utility for the lowest cost.

Table 2 Cost-benefit analysis

	Costs	Outcome	Benefit	Total benefits	Net benefit (total benefits – costs)
Simulation-based education	£20 000	8 complaints prevented	Benefit per complaint prevented = £1000	£8000	−£12 000
Communication skills teaching	£10 000	12 complaints prevented	Benefit per complaint prevented = £1000	£12 000	+£2000
Team-based learning	£25 000	5 medical accidents prevented	Benefit per medical accident prevented = £10 000	£50 000	+£25 000
Quality improvement education	£50 000	7 medical accidents prevented	Benefit per medical accident prevented = £10 000	£70 000	+£20 000

Medical education interventions typically result in many different effects at the same time. An intervention might result, for example, in better applied knowledge scores, better problem-solving skills and more professional behaviours. Cost-utility analysis should be based on the utility of the intervention and this should be drawn from all the different outcomes. In the real world, educators and learners may value one outcome above another; for example, educators might believe that, although all outcomes are important, more professional behaviours are most important. One way to capture this is to assign different weights to different interventions – in the example above professional behaviours might be weighted more heavily than applied knowledge outcomes.

The main advantage associated with cost-utility approaches is that they allow multiple outcomes to be taken into account in the evaluation. A secondary advantage is that they force the stakeholders to reflect on the relative merits of different outcomes and to articulate the results of their reflections and record them.

The main disadvantage of cost-utility analyses is that a number of different methods may be used to assign 'weightings' to different outcomes: this can lead to results that are difficult to reproduce because of the different methods used. Also, the subjective assessment of a potpourri of information and evidence may lead to different estimates of the probabilities of success on different outcomes as well as the placing of different values on them. Finally, like cost-effectiveness analysis, cost-utility analysis cannot determine the worth or otherwise of a single approach in and of itself – it can only be used when comparing a number of alternatives. Once again, as with cost-effectiveness analysis, the validity of the results of cost-utility analyses rely on our ability to be sure that the utility observed is caused by the intervention and not other factors.

Worked example: cost-utility analysis

A medical school is planning to change its curriculum. It finds a number of different programmes among neighbouring schools and decides to adopt one of these programmes rather than create its own. It compares programmes A and B. The costs, measures of effectiveness, overall utility and cost-utility scores are outlined in Table 3.

A medical school would obviously look at a wider range of measures of the effectiveness of a programme. However, for the purpose of simplicity, only satisfaction with lectures and with small group teaching is evaluated. If satisfaction with lectures and satisfaction with small group teaching are given equal weight, then the utility of programmes A and B are equal (11 + 8 = 9 + 10). However, perhaps the school gives more weight to satisfaction with small group teaching. It might give a weighting of 1 to satisfaction with small group teaching as opposed to a weighting of 0.5 to satisfaction with lectures. In this circumstance, the utility of programme A would be 11/2 + 8 = 13.5. The utility of programme B would be 9/2 + 10 = 14.5. The cost-utility ratios are shown in column 6. Even though programme B is more expensive, this analysis enables decision makers to realise that, due to programme B's higher satisfaction score on small group teaching and the increased weight given to this score, it has a better cost-utility score.

COST-FEASIBILITY ANALYSIS

Cost-feasibility analysis is the most straightforward of the various methods described. Cost-feasibility analysis involves simply measuring the cost of a proposed intervention in order to decide whether it is feasible (that is, whether it can or cannot be considered). For example, if the cost of a new simulation centre is £10 million and the budget available is £8 million,

Table 3 Cost-utility analysis

		Measure of effectiveness			
	Cost per student	**Satisfaction with lectures**	**Satisfaction with small group teaching**	**Utility**	**Cost-utility score**
A	£1000	11	8	13.50	74.07
B	£1050	9	10	14.50	72.40

then there is no point in doing further analysis of how useful the centre might be.

The advantages of this approach are that it is simple and quick to implement. It also makes explicit to stakeholders the need for a concrete method to estimate costs, such as the ingredients method. The ingredients method involves adding up all the costs of individual ingredients in a project to get to the total costs. The disadvantage of cost-feasibility analysis is that it cannot help us decide between alternative approaches nor can it help us decide if an approach is worthwhile, as it does not look at the effectiveness or utility of an intervention or the benefits that may be associated with it.

Worked example: cost-feasibility analysis

A medical school is planning to redesign its curriculum. It is a small school taking in 100 students per year. Currently it runs a traditional curriculum with mainly large group sessions – it plans to do more small group work in the future. It examines two options for small group sessions; one that would have five students per group and one that would have eight students per group. The options, total costs and costs per student are outlined in Table 4.

The annual medical school's budget for the next 3 years has been set at £1 500 000. Therefore, the only feasible option for the school (of the two described) would be to have a small group size of eight students. Cost-feasibility analysis can inform decision makers about the feasibility of changing to a curriculum with more small group work, but it cannot inform the decision makers as to the benefits that might accrue from smaller group sizes or to the relative cost-effectiveness or utility of this approach compared with other possible curricular changes.

Table 4 *Cost-feasibility analysis*

Small group size	Total costs of operating this system	Cost per student per year of operating this system
5	£1 800 000	£18 000
8	£1 400 000	£14 000

NEXT STEPS

At present, too few medical education researchers give sufficient thought to cost analyses. This is a pity, because cost analyses have the potential to show funders and users alike the effectiveness, benefits or utility associated with medical educational interventions. It is frustrating that more thought is not given to cost analyses; however, the current situation also provides an opportunity. Cost analysis sits at the interface of educational design and workforce planning and the current economic depression makes the need to demonstrate value for money more pressing. The current dearth of papers in this field means that almost any project that is carried out will be adding knowledge to the medical education literature. This is virgin territory and we are at the frontier.

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