EXPERT REVIEWS

Estimating the short-term clinical and economic benefits of smoking cessation: do we have it right?

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Joseph Menzin†, Lisa M Lines and Jeno Marton
†*Author for correspondence*
Boston Health Economics, Inc., 20 Fox Road, Waltham, MA 02451, USA
Tel.: +1 781 290 0808
Fax: +1 781 290 0029
jmenzin@bhei.com

Smoking cessation is cost effective from a long-term perspective, but less is known about its short-term cost–effectiveness. Short-term health benefits are clear for certain groups, such as cardiovascular patients, pregnant women and patients undergoing surgery. Smoking cessation reduces overall mortality, cardiovascular mortality and cancer-related mortality within 5 years of quitting, and, in some cases, the risks are reduced to the levels of never smokers. In this article, conducted from a USA policy perspective, we found some evidence of the clinical and economic benefits of smoking cessation in the short term, which could be incorporated into cost–effectiveness studies. Nonetheless, the policy and social welfare implications of a short-term focus must be carefully evaluated, considering the established favorable long-term cost–effectiveness of smoking cessation.

KEYWORDS: healthcare cost • smoking cessation • time factor

According to the US CDC, approximately 20% of US adults were current smokers in 2006 [101]. Among smokers, approximately 44% attempt to quit each year [101]. The USA Surgeon General reports that one in five deaths can be attributed to smoking, making it the leading cause of death and disease in the USA [102].

Seven first-line smoking-cessation aides available in the USA have been shown to reliably increase long-term smoking-abstinence rates, including five nicotine and two non-nicotine products [103]. Numerous studies have documented the clinical benefits of quitting smoking [1,102] as well as the favorable cost–effectiveness of smoking cessation interventions [2–9]. In fact, smoking cessation is often considered the gold standard for cost-effective health interventions [103]. Despite the favorable clinical and economic benefits associated with strategies aimed at smoking cessation, government and private insurers have been reluctant to offer routine coverage for pharmacologic therapies. This, in turn, appears to lead to underuse of effective smoking-cessation aids. It has been shown that quitting attempts and smoking-abstinence rates increase with prepaid and discounted prescription smoking-aide benefits [103]. Making smoking-cessation treatment a covered benefit increases the likelihood that tobacco users will receive treatment and quit successfully [10].

Some payers are reluctant to cover smoking-cessation interventions for a number of reasons, such as skepticism that users of smoking-cessation interventions will be enrolled long enough to permit an adequate return on investment, low perceived effectiveness in actual clinical practice and high budgetary impact, since over 20% of the population smokes in most Western countries [11,12]. Nevertheless, the most recent US Public Health Service guidelines for treating tobacco use and dependence recommend that all insurance plans include smoking-cessation counseling and medication as covered benefits [103].

Solid and credible estimates of the true cost–effectiveness of smoking-cessation strategies from the viewpoint of various payers are needed to better inform policies concerning coverage and reimbursement. The purpose of this article is threefold:

- To provide an overview of short-term clinical and economic effects of smoking cessation

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- To highlight methodologic and data gaps that need to be bridged to improve upon current estimates
- To discuss how decisions regarding coverage and reimbursement for smoking-cessation treatments may affect public health

For this review, we identified papers published over the last four decades that assess the short-term cost–effectiveness of smoking cessation, defined in terms of cost per life-year gained or cost per additional quitter. We also included papers that evaluated the clinical and economic effects of quitting smoking in the short term. We arbitrarily defined 'short term' as less than or equal to 7 years. To be included, studies were required to compare either smokers or nonsmokers with quitters and were required to report outcomes for quitters by time since cessation. The reason for this requirement was to attempt to gather precise data on the short-term effects of smoking cessation. For example, it is often asserted that smokers take more sick days than nonsmokers; we wanted to focus on studies that showed whether quitters take fewer or more sick days than either continuing smokers or never smokers and whether this varied by time since quitting. Similarly, it was not enough for a study to demonstrate cost or health differences between a cohort of smokers, ex-smokers and never smokers if the study combined all ex-smokers (those who quit yesterday and those who quit 20 years ago) in the same study population together. Out of 709 articles identified in searches of PubMed, EMBASE and other electronic sources, 60 articles met our inclusion criteria and were reviewed. The review was primarily conducted from a USA policy perspective.

Short-term clinical outcomes of smoking cessation

Smoking cessation is beneficial in primary prevention of disease (prevention before health problems occur), secondary prevention (prevention after diagnosis but before damage) and tertiary prevention (prevention after damage from disease), although most of the evidence of benefit comes from studies of smoking cessation as a secondary or tertiary intervention. Examples of each of these types of benefits are given in the sections that follow.

According to recent data from the Nurses' Health Study, the risk of mortality from all causes, vascular diseases, lung cancer or any smoking-related cancer is lower among female former smokers than among female continuing smokers within 5 years of quitting. Mortality risk from respiratory disease and other causes is higher among former smokers than continuing smokers for the first 5 years after quitting but decreases below the risk for continuing smokers by 10 years following quitting [13].

Smoking is an important risk factor for cardiovascular disease. Many cardiovascular effects of smoking are moderated by mechanisms that respond in the short term. Within days of complete smoking cessation, improvements can be seen in coronary vasoconstriction, adverse changes to lipoprotein profiles, oxidative modification of lipoproteins, endothelial damage, activation of leukocytes and prothrombic effects [14]. Quitters also have a lower risk of death from acute myocardial infarction (AMI) than current smokers do, which the Surgeon General suggests may be related to decreased blood coagulability, increased tissue oxygenation and lower predisposition for cardiac arrhythmias after smoking cessation [102].

While the cost to produce one successful quitter has been estimated to be approximately US$1000–1500, these costs are quickly recouped through reductions in AMI and stroke alone [15]. In a study analyzing incident coronary heart disease (CHD), nearly a third of the excess risk of CHD was eliminated within 2 years of quitting. Quitters' total risk of CHD approximates the risk of never smokers by 10–15 years following quitting [16]. Among men at high risk for CHD who quit within the past year, the adjusted relative risk of mortality from CHD for quitters compared with continuing smokers is 0.58 (95% confidence interval [CI]: 0.40–0.84). For men who quit 3 years previously, the adjusted relative risk (RR) of CHD mortality compared with continuing smokers is 0.35 (95% CI: 0.20–0.63) [17]. Within 5 years of smoking cessation, quitters' relative risk for stroke is similar to that of never smokers [18]. However, hospitalized heart disease patients followed for 1 year did not have a significant reduction in the adjusted odds of a secondary cardiovascular disease event among quitters compared with continuing smokers [19].

Smoking cessation has been shown to be as effective as other secondary preventive therapies, such as statins (for cholesterol control), aspirin, β-blockers and angiotensin-converting enzyme inhibitors, in reducing CHD-related mortality [20]. Smoking cessation has a comparable effect to the leading drug treatment in reducing morbidity and mortality in patients with left ventricular dysfunction [21]. In addition, quitters have a lower risk of hospitalizations related to myocardial infarction and stroke shortly after quitting smoking [20].

In multiple studies, cigarette smoking has been shown to increase the risk of developing diabetes mellitus in a dose-dependent manner, even after controlling for confounding variables, such as age, diet, weight and activity levels. This increased risk is reduced to the level of never smokers within 5–10 years after quitting for women and after 10 years or more for men [22]. This may, in turn, reduce the risk of a host of diabetes-related complications.

The risk of mortality from any cancer is lower for quitters than for current smokers within 5 years after quitting [13]. In addition, the risk of cervical cancer begins to decline in the first few years of successful smoking cessation. Former smokers have a lower adjusted RR for cervical cancer than current smokers (1.3 vs 1.5), but the risk is dependent on time since quitting. People who quit within 2–4 years have a negligible adjusted RR compared with never smokers (1.1) [23]. Smoking cessation does not have an observable effect on the mortality rate from lung cancer [17].

Chronic obstructive pulmonary disease (COPD) is the umbrella term for emphysema and chronic bronchitis. Most COPD patients are current or former smokers; 40–73% of COPD mortality is related to smoking, and approximately half of all smokers will develop COPD [24]. Among patients with COPD, lung function improves within a year after quitting, and the annual rate of decline in lung function over 4 years, as measured by forced expiratory volume in 1 s (FEV_1), is half the decline seen among continued smokers [25].

Approximately a third of surgical patients are smokers [26]. Smoking increases the risk of pulmonary, circulatory and infectious complications and impairs wound healing. Smokers have a higher rate of postoperative admission to the intensive-care unit than nonsmokers [26–28]. The largest improvements among former smokers are seen in wound healing, although cardiovascular complications are also reduced. Recent quitters spend less time in the hospital and far less time in the intensive-care unit. Smoking cessation as few as 6 weeks before surgery can more than halve postoperative complications [26]. Short-term preoperative smoking cessation decreases perioperative and postoperative complications. The longer the elapsed time between smoking cessation and surgery, the better the outcomes for the surgical patient [29].

Short-term cost impact of smoking cessation

The onset of smoking-related disease may prompt smoking cessation but may also increase the use of health services. After quitting, former smokers may seek medical care they had delayed while they were smokers, resulting in increased healthcare utilization [30]. Elevated healthcare use is often a predictor of a smoking-cessation attempt in the following year [20,30,31]. In observational studies, hospitalization rates for quitters increase in the short term, but decline over the subsequent 4–10 years to a rate at or below that of continuing smokers [30,32]. Increased hospital usage in the first year after quitting smoking is more likely to be a cause of smoking cessation than a consequence [30].

Healthcare costs typically increase steadily for 2 years before a smoking-cessation attempt. The commonly seen spike in costs during the first quarter after quitting may be related to acute health events that often prompt a cessation attempt [33]. In all age categories, smokers incur higher healthcare costs than do nonsmokers; among 65–74-year-old individuals, male smokers may incur costs up to 40% higher than those of nonsmokers of the same age, whereas for women, the costs may differ by up to 25% [34]. As with utilization, quitters have increased costs in the short term, which appears to reflect the fact that those who quit may be doing so after a smoking-related illness [33,35,36]. Costs for quitters tend to decline after approximately 2–5 years [35].

Employers incur smoking-related indirect costs because of workplace absenteeism and lost productivity. In a US study, annual absenteeism for smoking-related illness was found to be approximately 1.6 days lower for former smokers than for current smokers, although rates are still higher for former smokers than for never smokers. These results may not be generalized outside of the USA, given differences in other countries related to sick leave and holiday pay. Nonetheless, absenteeism has been shown to continue to decline in the years after smoking cessation in both US and Australian studies [37,38]. As with healthcare costs and utilization, productivity is worse for quitters during the first year after cessation, but quitters are more productive than current smokers 1–4 years after quitting [39].

Approximately 6–7% of smokers per year typically use smoking-cessation insurance benefits, at a per-member-per-month cost of approximately US$0.14 [40]. The 1-year return on investment ranges from 138 to 858% [41], and less-intensive smoking-cessation interventions have a break-even point at 1 year, whereas more-intensive interventions have a 2:1 cost–benefit ratio [42].

Past studies [41,42,44,45] have frequently referenced a paper, published in 1989, that drew from epidemiologic studies but contained a number of flawed and/or out-of-date assumptions [43]. For example, some of the cost to employers has been attributed to exposure to second-hand smoke, but more than 90% of all workers in the USA are now employed at establishments that have official smoking restriction policies [104,105]. In addition, a lack of data on absenteeism and productivity for recent quitters has required a number of models to make assumptions about potential improvements from smoking cessation. For example, several studies [41,42,46,106] have used Warner *et al.*'s outdated figure (based on data from an unreferenced year of the National Health Interview Survey) of 3.9 excess sick days for male smokers and 2.1 days for females, relative to never smokers [47]. The most recent data from the National Health Interview Survey, 2006, suggest that, relative to never smokers, current smokers take an excess of 2.8 sick days for males and 3.1 days for females [104]. By contrast, Fellows *et al.* assumed a 25% reduction in excess sick days for every year after quitting [106]. In the Javitz *et al.* model, absenteeism was reduced by the full differential amount in the first year after smoking cessation [46]. Another model assumed that the cost of absenteeism is 1% of a current smoker's salary [48].

Regarding productivity, the Fellows model assumes an excess of 5 min per day of break time for smokers, reduced to zero after quitting [48,106]. The Levy *et al.* model assumes 25% higher healthcare expenditures for the smoking population, decreasing by 20% each year after quitting. [48] The Warner *et al.* model assumed that current smokers' healthcare costs are 32% higher than never smokers' costs, regardless of age, and that costs fall proportionately after quitting relative to the decline in mortality risk for former smokers [49]. The assumptions used in these models indicate a pressing requirement for more research on sick time, productivity and healthcare costs for quitters by time since quitting.

In modeling studies, smoking cessation has been projected to reduce utilization of health resources and associated costs to the healthcare system. For example, a 1% decrease in the number of pregnant women who smoke would prevent 1300 low birthweight births and approximately US$21 million in associated medical costs in the first year. After 7 years, those numbers would rise to 57,200 prevented low birthweight births and US$572 million in medical cost savings [50]. The CDC recommends limiting children's exposure to secondhand tobacco smoke, as it is associated with the development of asthma and can cause exacerbations among those who already have asthma [51]. These acute respiratory events can be costly from a payer perspective and can increase workplace absenteeism among primary caregivers of children with asthma. A 1% drop in smoking prevalence would prevent 1000 hospitalizations for AMI and 350 hospitalizations for stroke over 7 years in Australia [52]. In addition, a 7-year program reducing smoking rates by 1% per year would prevent 63,480 hospitalizations for AMI and 34,261 hospitalizations for stroke, could yield US$3.2 billion in medical cost savings, and prevent 13,000 deaths that occur before AMI and stroke patients arrive at the hospital [53].

Discussion

The short-term clinical benefits of smoking cessation are particularly evident for certain groups of smokers, such as cardiovascular patients, pregnant women and patients undergoing surgery. Smoking cessation reduces overall mortality, cardiovascular mortality and cancer-related mortality within 5 years of quitting and, in some cases, the risks are reduced to the levels of never smokers.

However, the short-term economic benefits of smoking cessation are harder to measure. There is limited evidence of reduced hospitalizations or lower direct costs in studies of the general population, but there is some evidence in specific groups, such as those with heart disease or undergoing orthopedic surgery. Observational studies and models have found conflicting results in terms of the short-term impact of smoking cessation on healthcare utilization. Most of the published decision analytic models report savings that are largely based on assumptions that may be out-of-date and/or flawed. Epidemiologic-based models are more convincing, but typically have been limited to specific populations.

Policy considerations

How well are smoking-cessation strategies covered by insurance?

Better data on the cost–effectiveness of smoking cessation could improve coverage and access to smoking-cessation interventions. This leads to the question of the status of such coverage in the USA. Health plans have begun to use evidence-based medicine and clinical guidelines put forth by groups such as the Public Health Service and the Agency for Health Care Policy and Research (now the Agency for Healthcare Research and Quality) to address tobacco use and cessation therapy coverage. In 2003, 88% of surveyed private health plans provided coverage for at least one pharmacotherapy smoking-cessation aid (generally the generic medication bupropion), and at least one behavioral smoking-cessation therapy was covered by 76% of health plans [54]. The most common behavioral therapy offered was self-directed online resources, which can be provided at almost no cost to the plan [54]. Unfortunately, it appears that few insurers cover nicotine replacement or other forms of pharmacotherapy, and the survey has not been conducted since 2003 [54].

Even when smoking-cessation therapy is covered, the proportion of smokers who use the benefit is fairly low historically (6–7%) [40]. Considering that approximately 44% of smokers attempt to quit every year [101], the lack of uptake among smokers may be partly the result of poor communication between payers and patients about what therapies are and are not covered [55]. Other barriers to patient access to effective therapies may include offering therapy only through the purchase of a rider, pre-authorization policies, step therapy, pre-enrollment in behavior modification programs, onerous enrollment procedures, high copayments and high deductibles.

Medicare covers two quit attempts per year. For each quit attempt, the total benefit covers up to four intermediate (3–10 min) or intensive (>10 min) counseling sessions, covering eight total sessions annually. In order to qualify, the beneficiary must have a health condition that is exacerbated by smoking or tobacco use or use a prescription drug that is adversely affected by the use of tobacco products. Beginning in January 2006, Medicare Part D covered prescription smoking-cessation aides but not over-the-counter aides, such as nicotine patches or gum.

Medicaid coverage varies by state with respect to eligible populations, benefit type and counseling availability. As of 2006, approximately 15% of states do not offer any coverage [107]. Medicaid programs, similar to private payers, may be primarily concerned with short-term benefits, since between a quarter and a third of a typical state's caseload turns over every year [108]. According to a Washington state analysis, smoking-cessation programs would not help to lower the cost of the Medicaid program, although the benefit–cost ratio would be between 0.07 and 0.57. For example, if Medicaid spent US$332 for counseling and nicotine nasal spray per quit attempt, it would reap US$106.38 in avoided healthcare costs per quit attempt (in 2001 dollars), yielding a benefit–cost ratio of 0.32 [109].

The experience of the UK's National Health Service (NHS) regarding universal coverage of smoking-cessation treatments is promising. From April 2000 to May 2001, 127,000 people made an attempt at quitting and a remarkable 48% achieved at least short-term abstinence [56]. Previous studies of abstinence rates in untreated smokers indicate a range of abstinence after 1 year of between 3 and 5% [57,58]. For those smokers who receive some treatment, 1-year abstinence rates are still only between 4 and 13% [58,59]. In the UK, the cost to the NHS was less than GB£800 (in 2000) per life-year gained, which is an excellent value by any measure [110]. By comparison, the NHS sees a cost–effectiveness ratio of GB£4000–13,000 per life-year gained with statin therapy to lower cholesterol [60].

The WHO publishes data on coverage of nicotine-replacement therapy and bupropion by national health systems in 53 countries in Europe. According to the latest data available, only 9% offer reimbursement for bupropion therapy as part of their national healthcare systems, whereas 11% reimburse nicotine-replacement therapy products, such as the patch [111]. The WHO Framework Convention on Tobacco Control of 2003, which currently has more than 160 signatory countries, was the first treaty negotiated under the WHO's auspices and the world's first global public-health treaty. The treaty requires that signatories attempt to address the demand for tobacco, in part, through taxation and bans on advertising; reimbursement of nicotine-replacement therapy or other smoking-cessation aides was not given high priority, but was mentioned as a potentially cost-effective strategy as well [61].

Is too much attention focused on short-term 'payback'?

Policymakers and payers may have conflicting priorities regarding tobacco control. A short-term focus may lead to suboptimal investment in smoking cessation from a broader societal view because of the issue of 'free riders' – employers may leave it to other firms to invest in smoking cessation and reap the benefits when they hire ex-smokers. Members of the legal community have recently devised a proposal to handle situations in which an insured person, who has received an intervention that has a long-time horizon for cost–effectiveness, switches insurers [62]. The proposal is for a

mandatory insurance clearinghouse, managed by and operated by the insurers themselves, which would involve transfer payments between insurance companies. The case study described in the proposal was for bariatric surgery, but smoking-cessation therapy could have been an equally valid case. In both cases, insurers may not have sufficient incentives to cover the intervention because they may not pay for themselves within 3 years (the average tenure of a health plan member's enrollment) [62].

Might smoking cessation have a place in value-based purchasing for insurers & patients?

Value-based purchasing in health insurance is a way for public and private purchasers to influence the quality and costs of healthcare. Payers can use their purchasing power to improve the quality of health programs, especially by rewarding or penalizing plans or providers using incentives or disincentives [112]. Using coverage of smoking-cessation counseling as a quality benchmark and measure for financial incentives has been proposed for the Medicare hospital value-based purchasing program [113], and similar measures could be taken by private employers. In addition, plans could waive copayments for smoking-cessation therapies.

Is smoking cessation treated differently than other preventive strategies with limited evidence of short-term payback?

Smoking cessation has been called the gold standard of preventive treatment [103]. It is estimated that an investment of US$1 million into an anti-tobacco education program would save 7000 person-years of life. This makes smoking cessation approximately ten-times more valuable than other preventive-care strategies that receive near-universal coverage by payers, such as treatment for diabetes, hypertension and dyslipidemia [63]. Perhaps there is a connection between the perceived short-term return on investment, actual coverage of different preventive strategies and the apparent self-inflicted nature of smoking-related health problems.

Expert commentary

The two main questions that remain to be adequately answered by studies conducted to date include: does smoking cessation result in short-term savings in direct costs and what are the effects of smoking cessation on work productivity? The question of direct cost savings is tricky because of the spike in healthcare utilization that is often seen among recent quitters. In addition, older ex-smokers and never smokers accrue greater lifetime healthcare costs than smokers do. Costs are greatest in old age, an age that many smokers do not reach because of smoking-related mortality.

There is some debate among health economists over whether unrelated costs accrued during additional years of life should be included when calculating cost–effectiveness, particularly for primary preventions, such as smoking cessation [64]. For example, if a person stops smoking and, thereby, extends his or her life through prevention of a CHD event, the cost savings from the reduced incidence in CHD events is obviously related and should be included. However, what if that person develops arthritis later in life? Should the costs involved in treating arthritis be subtracted from the cost savings arising from prevention of a CHD event? Regardless of which specific future costs are included, incorporating them will make preventive strategies less cost effective than they would be otherwise and potentially bias comparisons of the economic value of preventative versus therapeutic interventions in clinical medicine [65].

The question of the effects of smoking cessation on productivity is especially relevant to employers, who incur indirect costs from smoking because of workplace absenteeism and productivity loss. In one of the few studies of absenteeism and the indirect costs of smoking, quitters were shown to have absenteeism rates between those of never smokers and continuing smokers [37]. Absenteeism continued to decline in the years after smoking cessation and the workplace productivity of quitters returned to that of a never smoker in 1–4 years [37]. Additional well-designed studies of the indirect costs of smoking are urgently needed.

Some of the studies discussed in this review could be used in models to better understand the value of smoking cessation over the short term. Existing economic models have a few shortcomings, most notably a lack of good data on the short-term effects of smoking cessation on absenteeism and workplace productivity. In addition, existing studies have frequently been too short to see clear benefits. Few researchers have adequately compared different populations of quitters, such as younger versus older and healthier versus sicker populations. More-creative thinking may be needed in order to build more accurate models of smoking cessation. The main gaps we have identified are in the areas of productivity and absenteeism and the need to control for bias in direct cost assessment related to smoking cessation prompted by health problems.

Five-year view

The policy and social welfare implications of focusing on the short term need to be carefully considered given that smoking cessation is clearly cost effective in the long term. We predict that a short-term perspective will continue to be the norm in the USA in calculating the benefits of smoking cessation from an employer or payer perspective. However, national health systems, such as the NHS, are able to focus on the longer term, leading to more and better smoking-cessation coverage, with great results. As the USA considers expanding the government's role in paying for healthcare, it is imperative that policymakers consider the time horizon used in calculating the return on investment for smoking-cessation therapy.

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Key issues

- Cost–effectiveness models indicate that a US$1 million investment in anti-tobacco education would save 7000 life years, making smoking cessation roughly ten-times more effective than other preventive therapies. Nevertheless, smoking-cessation therapy is inadequately covered by many USA public and private health insurance plans.
- Reasons for opposition to more comprehensive smoking-cessation therapy coverage by public and private payors may include perceived poor return on investment, as insurance beneficiaries switch plans on average every 2–3 years, and greater end-of-life costs when smoking-related mortality is reduced and former smokers live longer than they otherwise might.
- Although smoking cessation is clearly beneficial in the long run, little has been published about the short-term economic and clinical effects of a successful cessation attempt. Better data on the cost–effectiveness of smoking cessation could improve coverage and access to smoking cessation interventions.
- Existing economic models of the short-term effects of smoking cessation have a few shortcomings, most notably a lack of good data on the short-term effects of smoking cessation on absenteeism and workplace productivity. In addition, existing studies have frequently been too short to see clear benefits.
- A short-term focus may lead to suboptimal investment in smoking cessation in the USA from a broader societal view. The policy and social welfare implications of focusing on the short term need to be carefully considered, given that smoking cessation is clearly cost effective in the long run.

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Affiliations

- Joseph Menzin, PhD
Boston Health Economics, Inc., 20 Fox Road, Waltham, MA 02451, USA
Tel.: +1 781 290 0808
Fax: +1 781 290 0029
jmenzin@bhei.com
- Lisa M Lines, MPH
Boston Health Economics, Inc., 20 Fox Road, Waltham, MA 02451, USA
- Jeno Marton, MD
US Outcomes Research Group, Pfizer Global Pharmaceuticals, 235 East 42nd Street, NY 10017, USA