Original Research

Cost-effectiveness of primary tetanus vaccination among elderly Canadians

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Although tetanus is now rare, vaccination is currently recommended for the entire population. Most elderly North Americans have never received tetanus vaccination. We evaluated the expected cost-effectiveness of using mailed reminders from family physicians to increase primary tetanus vaccination coverage among elderly Canadians. We estimated that over 10 years the program would prevent five cases of tetanus and one death from tetanus, resulting in a gain of 13 life-years. There would be 16 700 adverse reactions to tetanus toxoid, 17% in people already immune to tetanus. The net cost of the program (in 1984 Canadian dollars) would be $1.9 million per case of tetanus prevented, $7.1 million per death prevented and $810 000 per life-year gained. These high cost-effectiveness ratios are largely attributable to the very low risk of tetanus, even among nonimmune elderly people. Tetanus toxoid and physicians' services for vaccination would account for 86% of the program costs. Because the mailed reminders would be responsible for only 13% of the program costs, other possible programs to increase primary tetanus vaccination coverage could not be expected to have substantially lower cost-effectiveness ratios. We conclude that efforts to increase primary tetanus vaccination coverage among elderly Canadians would be a questionable use of health care resources.

En dépit de la rareté actuelle du tétanos on recommande encore que toute la population soit vaccinée contre lui. La plupart des personnes âgées en Amérique du Nord ne l'ont jamais été. Nous examinons la rentabilité attendue d'un programme d'aide-mémoire postaux par les médecins omnipraticiens pour augmenter le taux de vaccination antitétanique primaire chez les Canadiens âgés. Nous estimons qu'en 10 ans cette pratique préviendrait cinq cas de tétanos et un décès, soit un gain de 13 années de vie. Il surviendrait 16 700 réactions fâcheuses à l'anatoxine, dont 17% chez des sujets déjà immunisés. Il en coûterait 1,9 millions de dollars canadiens de 1984 par cas prévenu, 7,1 millions $ par décès prévenu et 810 000 $ par année de vie gagnée. Ces rapports coût-effet très élevés reposent surtout sur la rareté de la maladie chez les personnes âgées, même non vaccinées. Le prix de l'anatoxine et les honoraires de médecins rendraient compte du 86% du coût prévu. Comme les aide-mémoire eux-mêmes n'entraîneraient que 13% de celui-ci, on ne saurait envisager d'autres méthodes d'augmenter la protection vaccinale avec une meilleure rentabilité. Les auteurs pensent que les efforts qu'on ferait pour hausser le taux de vaccination antitétanique primaire chez les Canadiens âgés représenteraient un emploi douteux des ressources sanitaires.

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But this leaves the older generation largely unprotected, and there are no properly supported programs for them. Here more than anywhere else the practicing physician can take the lead in making sure that every patient he sees is immunized against tetanus.

This exhortation from an editorial in *JAMA*, dramatically entitled "The inexcusable disease",[1] is representative of commentary in the general medical and geriatric literature on tetanus vaccination in the elderly. Vaccination

against tetanus is recommended for elderly people by both the US and the Canadian national advisory committees on immunization[2,3] and by the Canadian Task Force on the Periodic Health Examination.[4] These recommendations are based on several observations about the current status of tetanus and tetanus immunization.

- A highly efficacious preventive intervention is available in the form of tetanus toxoid.[5-7]
- A large proportion of elderly people are not vaccinated against tetanus.[8-13]
- The incidence of tetanus is highest among the elderly.[14-18]
- The case-fatality ratio for tetanus is highest among older people.[14,15,17]
- The elderly account for a large proportion of deaths from tetanus.[19,20]

These facts argue in favour of heightened efforts to deliver tetanus toxoid to elderly people who have not had full primary vaccination. Given the rarity of tetanus,[20-22] however, the economic efficiency of such efforts is questionable. No economic evaluation of tetanus vaccination has been reported in the health care literature.[23]

The existing tetanus vaccination program consists of administration of tetanus toxoid by primary care physicians on a routine basis or at the time of wounding. The available evidence indicates that this approach has been singularly ineffective in achieving tetanus immunization in the elderly population.[8-13] The current cohort of elderly Canadians left the school system well before the introduction of tetanus vaccination in the schools, in 1948. Repeated admonishment of primary care physicians to vaccinate elderly people against tetanus appears to have had little or no effect on levels of immunity. Further pleas, however authoritative, cannot be counted on to be effective. Increasing the level of immunity among elderly people seems to require the addition of some new element to the existing program.

We carried out a study to evaluate the efficiency of potential programs to increase tetanus vaccination coverage among the elderly. Four programs were considered: mailed reminders from health ministries, media promotion of vaccination, delegation of responsibility for vaccination to family practice nurses and mailed reminders from family physicians. We discarded the first two for lack of credible evidence of efficacy. The third alternative has not been evaluated in a family practice setting. However, in two cohort (nonequivalent comparison group) studies in medical outpatient clinics this strategy appeared to produce a substantial increase in influenza vaccination coverage.[24,25] Ultimately this program was rejected because of scanty evidence of effectiveness and lack of feasibility in the short term in many family practices. The program selected was thus one of mailed reminders from family physicians to their elderly patients. With this program patients who have not had full primary vaccination against tetanus, as defined according to criteria presented in the reminder letter, would be urged to obtain it.

The effectiveness of mailed reminders has been assessed in relation to influenza (but not tetanus) vaccination among elderly family practice patients in two randomized controlled trials[26,27] and a before-after study.[28] In each study influenza vaccine coverage more than doubled with the use of mailed reminders. A randomized trial in a pulmonary clinic produced similar results.[29]

The question addressed in this evaluation was, Compared with the existing program, what clinical outcomes are achievable at what net cost with a program of mailed reminders designed to increase primary tetanus vaccination coverage among elderly Canadians? "Net cost" refers to incremental (i.e., extra) health care costs generated by such a program, minus future savings in health care costs resulting from the program. We did not consider possible efforts to promote booster injections of tetanus toxoid among immune people because of uncertainty in the literature about the necessity of routine (as opposed to wound-related) booster doses[30,31] and the evidence that most elderly people have not had full primary vaccination.[8-13]

Cost-effectiveness analysis was selected as the most suitable form of economic evaluation for this study. Cost-effectiveness analysis involves estimation of the costs of achieving particular clinical outcomes (e.g., a life saved or a year of life gained). The main clinical outcome of tetanus vaccination is the prevention of tetanus, a serious illness leading to either death or complete recovery within a few weeks. In addition, tetanus vaccination causes local or systemic adverse reactions in a small minority of vaccine recipients.

Methods

The analysis was conducted from the perspective of the publicly financed health care sector. Formulating policies on and making decisions about vaccination are likely to be done from the perspective of this sector rather than from a broader societal viewpoint, which would include, for example, out-of-pocket expenses of patients and families as well as consideration of the program's effects on productivity. The study was planned so that the perspective could be broadened if it appeared that such a change might influence decision-making.

Because we were comparing the mailed-reminder program with the existing program, we estimated only incremental costs and outcomes related to the new program. No attempt was made to determine the costs of the existing program. For the purposes of assessing the potential effect of

mailed reminders, we assumed full participation by all Canadian family physicians.

The length of time used in the analysis was 10 years. We chose this period because the duration of immunity gained through active vaccination is at least 10 years in most recipients.[30-32] We assumed that all vaccination would occur (and all costs of the program would be incurred) during the first 2 years of the program (65% in year 1 and 35% in year 2). Because primary tetanus vaccination, as currently recommended,[3] requires up to 13 months to complete, the full effect of the program would not be realized until year 3. We assumed that the number of cases of tetanus prevented would be 25% and 65% of the full potential in years 1 and 2 respectively.

The existing program and the mailed-reminder program are modelled in Fig. 1. All Canadians who were 65 years of age or older in 1984 were entered into the decision tree, in one of four age–sex subgroups. For years 2 to 10 adjustment was made for deaths within the cohort from causes other than tetanus, on the basis of Canadian life tables for 1980–82[33] and population estimates for Canada as of June 1, 1984.[34] Adsorbed toxoid was selected for evaluation because the primary series involves three injections rather than the four required with fluid toxoid. In addition, adsorbed toxoid is reported to convey more predictable and longer-lasting immunity.[35,36] We assumed full compliance with subsequent vaccination by people responding to the mailed reminder.

Probability of clinical events

To determine the expected costs and outcomes of a health care intervention, estimates must be made of the likelihood of possible clinical or administrative events associated with the program. The relevant events for the current and mailed-reminder programs are shown as chance nodes (circles) in Fig. 1. Probability estimates were derived from published and, in a few instances, unpublished data.

Because immunity to tetanus, the risk of contracting tetanus and the tetanus case–fatality ratio vary with age and sex, we calculated the probability of clinical events separately for men aged 65 to 74 years, men aged 75 years or more, women aged 65 to 74 years and women aged 75 years or more. When there was substantial uncertainty we made upper- and lower-limit estimates in addition to a best estimate.

The incidence of tetanus was calculated on the basis of Canadian hospital morbidity data and Canadian population estimates for 1971–78.[21,22] Hospitalization rates can be expected to provide an accurate measure of the incidence of tetanus because of the severity and classic dramatic presentation of the disease. We calculated case–fatality ratios by combining disease-specific mortality data and hospital morbidity data.[21,22]

Levels of immunity to tetanus were estimated from reports of serologic testing in US and Canadian populations.[8-13] The samples tended to be

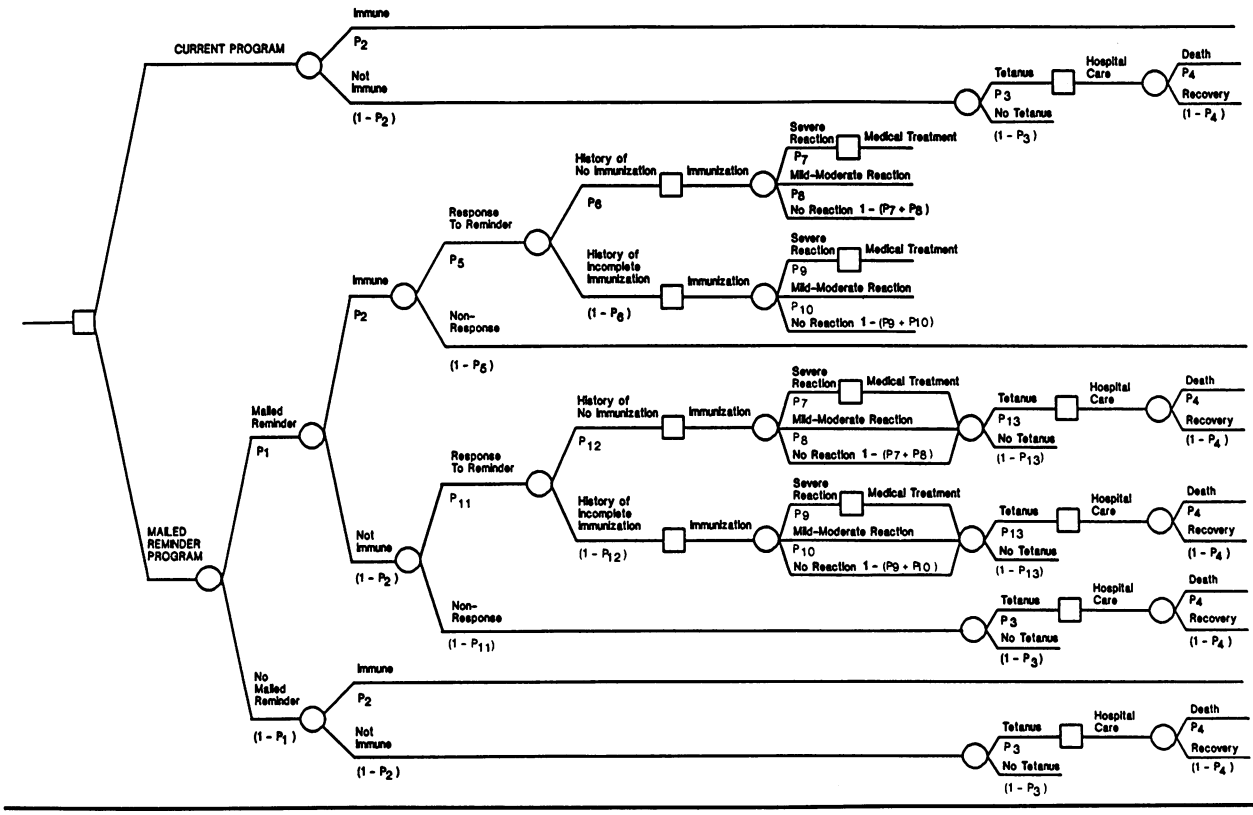

Fig. 1 — Decision tree for current program of tetanus vaccination and program using mailed reminders. ○ = chance nodes; □ = decision nodes.

small[8,10,11,13] or to be drawn from limited populations.[9,12] Information provided by the Department of Veterans Affairs was used to estimate the proportion of elderly Canadians vaccinated as a consequence of service in the armed forces during World War II or the Korean War.

We derived estimates of the efficacy/effectiveness of active vaccination against tetanus from a double-blind randomized controlled trial of maternal vaccination for the prevention of neonatal tetanus[7] and nonexperimental studies in injured armed forces personnel during World War II.[5]

The likelihood of having a family physician — and therefore the probability of receiving a mailed reminder — was estimated from Manitoba health insurance data.[37] Estimates of the probable effect of mailed reminders were based on studies of mailed reminders for influenza vaccination.[26,28]

Because response to an offer of tetanus vaccination and subsequent clinical management are in part determined by patients' recollection of previous vaccination, quantitative estimates of the relation between serologic immune status and vaccination history were critical to the calculation of the probability of several clinical events. We obtained these estimates from a study comparing information reported at interview and results of serologic testing in a 1% systematic sample of households in Washington County, Maryland.[38] Interviews were completed for 93% of the households in the sample. Data on serologic immunity to tetanus were available for only a minority of those interviewed owing to refusal of venipuncture and insufficient serum for testing. Tetanus antitoxin levels were measured in only 28% of the serum samples from subjects over 15 years of age. Although the final number of adults in whom tetanus immunity was studied was small (108), we could not identify any other studies of this nature in the literature.

Estimates of the probability of adverse reactions were based on a report by White and colleagues.[39] We selected this study because of the large number of injections studied (6740), the completeness of follow-up, the use of adsorbed toxoid and the presentation of data relating specifically to primary vaccination as opposed to booster injections.

People with a history of no previous vaccination were assumed to receive three injections of adsorbed toxoid, in keeping with current recommendations.[3] Those giving a history of incomplete vaccination were assumed to receive one or two injections to complete the primary vaccination series (best estimate: 50% one injection, 50% two injections). People experiencing a severe adverse reaction were assumed not to receive further injections. Although such people would not have received full primary vaccination, they were considered to be protected against tetanus. This assumption is in keeping with studies of adverse reactions, which have tended to show high antitoxin titres.[40-42] The probability of experiencing an adverse reaction, given a history of no previous vaccination or incomplete vaccination, was calculated by multiplying the probability of an adverse reaction to a single injection by the average number of injections required to complete the primary vaccination series.

The best estimates of the probability of clinical events are shown in Table I. Of note is the very low estimated probability of contracting tetanus, even among nonimmune elderly people. In the

Table I — Best estimates of the probability of clinical events in a tetanus vaccination program using mailed reminders

	Age, yr; estimate			
	Men		Women	
Event	65–74	≥75	65–74	≥75
Mailed reminder (P_1)	0.85	0.85	0.85	0.85
Immune (P_2)	0.5	0.25	0.25	0.15
Contract tetanus if not immune (P_3)	0.554×10^{-5}	0.464×10^{-5}	0.235×10^{-5}	0.706×10^{-6}
Death from tetanus (P_4)	0.31	0.375	0.11	0.5
Respond to reminder if immune (P_5)	0.15	0.15	0.15	0.15
History of no vaccination if immune and respond (P_6)	0.2	0.2	0.2	0.2
General or severe local reaction if history of no vaccination (P_7)	0.0197	0.0197	0.0197	0.0197
Mild to moderate local reaction if history of no vaccination (P_8)	0.0298	0.0298	0.0298	0.0298
General or severe local reaction if history of incomplete vaccination (P_9)	0.0099	0.0099	0.0099	0.0099
Mild to moderate local reaction if history of incomplete vaccination (P_{10})	0.015	0.015	0.015	0.015
Respond to reminder if not immune (P_{11})	0.24	0.24	0.24	0.24
History of no vaccination if not immune and respond (P_{12})	0.55	0.55	0.55	0.55
Contract tetanus if vaccinated (P_{13})	0.277×10^{-6}	0.232×10^{-6}	0.118×10^{-6}	0.353×10^{-7}

subgroup at highest risk, men aged 65 to 74 years, the annual risk is less than 1 in 180 000.

Clinical outcomes

We calculated values for clinical outcomes for the two programs for each year of the program by multiplying the probability associated with each branch of the decision tree by the number of people entering that branch. These values were then summed across the branches and finally across the age–sex subgroups. Values for incremental clinical effects of the mailed-reminder program were derived by subtracting values for outcomes of the existing program from values for outcomes of the mailed-reminder program. Values for future clinical outcomes were discounted to the current value at 5% per annum.

Life-years gained through prevention of death from tetanus were estimated from Canadian life tables for 1980–82[33] and Canada population estimates as of June 1, 1984.[34]

Costs

All costs were calculated in 1984 dollars. When there was substantial uncertainty we made upper- and lower-limit estimates along with best estimates.

We used estimates of the cost of mailed reminders calculated by Frank, McMurray and Henderson,[43] with adjustment for inflation on the basis of the Canadian consumer price index. The cost to the Ontario Ministry of Health of tetanus toxoid plus an allowance of 2¢ per dose for distribution was used in calculating vaccine costs.

Estimates of the cost of physicians' services were based on the 1984 payment schedule of the Ontario Health Insurance Plan (OHIP). For the initial visit/injection the base-case (best-estimate) assumptions about physician billing were as follows. Half of the patients responding to a mailed reminder would make a special visit for tetanus vaccination, and the physician would bill for a minor assessment plus injection. The other half of the responders would raise the issue of tetanus vaccination during a visit for other reasons. In half of these cases the physician would bill for an intermediate assessment plus injection rather than a minor assessment. The cost attributed to such visits was the injection fee plus the difference between the intermediate and minor assessment fees. In the remaining cases the physician would bill for an injection plus whatever would have been billed had vaccination not been addressed. For subsequent visits/injections we made the following base-case assumptions. Half of subsequent injections would be given at visits that otherwise would not have occurred. In half of these cases the physician would bill for a minor assessment plus injection, and in the remaining half the physician would bill for an injection only. The other half of subsequent injections would be given at visits that would have occurred in any event, and the physician would bill for an injection.

Table II — Costs of the components of the mailed-reminder program (in 1984 dollars)

Component	Cost, $		
	Lower limit	Best estimate	Upper limit
Mailed reminder	0.62	0.65	0.72
Vaccination			
Vaccine cost per injection	1.70	1.70	1.70
Physicians' services			
Cost per initial injection	6.00	9.19	12.38
Cost per subsequent injection	2.21	5.40	9.15
Treatment of adverse reactions (cost of physicians' services per general or severe local reaction)	9.56	12.75	12.75

For the base-case estimate of treatment costs of adverse reactions we assumed that all patients with general or severe local reactions would be seen by a physician and that the physician would bill for a minor assessment.

Other plausible scenarios were generated as the basis for upper- and lower-limit estimates of the cost of physicians' services for vaccination and treatment of adverse reactions. The costs of individual components of the mailed-reminder program are shown in Table II.

We estimated two costs associated with clinical tetanus: hospital costs and cost of physicians' services. We calculated the average length of hospital stay to be 30.3 days on the basis of disease-specific Canadian hospital morbidity data for 1971–78.[21] From the description of the clinical course of tetanus in a standard text[44] we conservatively assumed that the first 20 days would be spent in an intensive care unit (ICU) and the balance on a medical or surgical ward. The average per-diem rate for Canadian public general teaching hospitals ($378.16)[45] was used to calculate the best estimate and upper-limit estimate of hospital ward costs. We used the average per-diem rate for all public general hospitals ($294.93)[45] to calculate the lower-limit estimate. Daily ICU costs were estimated by multiplying the per-diem rates by 4.24, which was the ratio of paid hours per patient day in the ICU to paid hours per patient day for the hospital in general at McMaster University Medical Centre, Hamilton, Ont., in 1984.

Estimates of the probability of requiring specific physicians' services and the quantities required were obtained by interview with the direc-

tor of a university-affiliated ICU (Table III). The probability of tracheostomy was calculated from data from the US national morbidity reporting system.[46] Costs of specific services were taken from the OHIP payment schedule. Estimates of the health care costs associated with a case of tetanus are shown in Table IV.

We calculated incremental costs of the mailed-reminder program in a manner analogous to that used to calculate incremental clinical outcomes. Because the program would be added to the existing program, all associated costs would be incremental. All future costs were discounted to the current value at 5% per annum.

Table III — Estimates of the probability of requiring physicians' services for tetanus and the number of visits required

Service	Probability
Consultation	
Internal medicine	1.0
Infectious disease	1.0
Neurology	0.5
Surgery	
For parenteral nutrition	0.25
For wound débridement	0.1
Anesthesia (for neuromuscular blockade or sedation)	0.5
Surgical procedure	
Wound débridement requiring general anesthesia (surgeon and anesthetist)	0.1
Tracheostomy (surgeon and anesthetist)	0.5
Diagnostic/therapeutic procedure	
Assisted ventilation (2 wk)	0.5
Cannulation of central vein for pressure measurements or feeding line	0.5
	No. of visits
Subsequent hospital visits	
Intensive care unit	
Internal medicine	20 (1/d)
Infectious disease	13 (1/d for 1 wk, then alternate days)
Neurology (if initial consultation)	4
Surgery	
If parenteral nutrition required	3 (1 to 2/wk)
If wound débridement required	2
Anesthesia (if neuromuscular blockade or sedation required)	5
Family medicine (supportive care)	7 (every 3 d)
Medical or surgical ward	
Internal medicine	5 (alternate days)
Family medicine (supportive care)	3 (every 3 d)

Table IV — Health care costs per case of tetanus (rounded to nearest $100)

	Cost, $		
Variable	Lower limit	Best estimate	Upper limit
Hospital costs	23 700	36 000	42 700
Cost of physicians' services	1 200	1 700	2 200
Total	24 900	37 800	44 900

Results

The incremental costs (undiscounted) of the mailed-reminder program are shown in Table V. Physicians' services for vaccination accounted for 69% of the costs.

The current value of the incremental costs and outcomes of the mailed-reminder program over 10 years is shown in column 1 of Table VI. With the program five cases of tetanus and one death from tetanus would be prevented, and 13 life-years would be gained. Because of patients' imperfect recall of vaccination history, 17% of adverse reactions would occur in people already protected against tetanus.

The incremental cost-effectiveness ratios for the mailed-reminder program are shown in column 1 of Table VII. The estimated net cost per life-year gained was $810 000.

To assess the robustness of the findings, we

Table V — Best estimate of the incremental costs of the mailed-reminder program (undiscounted, rounded to nearest $1000)

Component	Cost, $
Mailed reminder	1 413 000
Vaccination	
Vaccine	1 819 000
Physicians' services	7 281 000
Treatment of adverse reactions	86 000
Total	10 598 000

Table VI — Current value of the incremental costs and outcomes of the mailed-reminder program over 10 years (rounded to nearest $10 000, nearest 100 adverse reactions, and nearest case, death and life-year)

Costs/outcome	Base case	Most favourable case
Direct program costs, $	10 420 000*	6 420 000
Health care costs averted (direct benefits), $	200 000	250 000
No. of cases of tetanus prevented	5	6
No. of deaths from tetanus prevented	1	1
No. of life-years gained	13	13
No. of general or severe local adverse reactions	6 600	2 900
No. of mild to moderate local adverse reactions	10 100	6 000

*This value differs from that in Table V because costs incurred in the second year of the program were discounted to their current value.

carried out a sensitivity analysis using the estimates of costs and probability of clinical events that would be most favourable to the mailed-reminder program (lower-limit estimates of all costs of the program, of P_6–P_{10}, P_{12} and P_{13} [Table I], and of the probability that an immune subject would report no history or an incomplete history of vaccination [reduces P_5], and upper-limit estimate of the health care costs per case of tetanus). All values were varied simultaneously.

The current value of the incremental costs and outcomes of the mailed-reminder program in the most favourable case is shown in column 2 of Table VI. The direct program costs were 38% lower than in the base case, the direct benefits were 25% higher, and the number of severe local or general reactions was 56% lower. The cost-effectiveness ratios in the most favourable case are shown in column 2 of Table VII. For each variable the ratio was 42% lower than in the base case.

Discussion

The methods we used to estimate costs associated with clinical tetanus were less rigorous than those used elsewhere in the analysis. Basing estimates of hospital costs for a specific disease on average per-diem costs can give rise to substantial inaccuracy. Similarly, relying on the experience of a single ICU director to estimate requirements for physicians' services could have produced an inaccurate estimate of the cost of physicians' services during a hospital stay for tetanus. However, given that the best estimate of health care costs averted through prevention of tetanus was 1/50 the incremental cost of the mailed-reminder program, even much larger estimates of costs associated with clinical tetanus would not materially alter the outcome of the analysis. Accordingly, the use of sophisticated methods to estimate these costs did not seem warranted given the increased resources that would have been required to conduct the study.

Even allowing for imprecision of estimates, the use of mailed reminders to increase primary tetanus vaccination coverage among the elderly could be expected to produce small health benefits at very high cost. The cost-effectiveness ratio per life-year gained in the most favourable case, $470 000, is high compared with costs of other interventions, such as influenza vaccination. On the basis of data from the 1960s Klarman and Guzick[47] estimated the net cost of vaccinating all elderly people in the United States against influenza to be $310 to $600 per life-year gained (in 1976 US dollars [equivalent to $825 to $1860 in 1984 Canadian dollars]). In a more recent analysis, by the Office of Technology Assessment, the US influenza vaccination program for the elderly was estimated to result in a net saving in medical costs of 25¢ US per vaccination and a net gain in healthy life of 28 days per vaccination during the period 1971–72 to 1977–78.[48] The key factor giving rise to the unfavourable cost-effectiveness ratios in our analysis is the very low risk of tetanus among nonimmune elderly people. Although the risk is considerably higher than that for younger adults, it is nevertheless tiny.

We could have carried out other sensitivity analyses of uncertain estimates (i.e., the probability of having a family physician and thus being sent a reminder, the probability of being immune to tetanus and the probability of responding to a mailed reminder). However, changes in these variables could not be expected to substantially affect cost-effectiveness ratios. Altering any of these

Table VII — Cost-effectiveness ratios* for the mailed-reminder program

Variable	Cost, $	
	Base case	Most favourable case
Net cost per case of tetanus prevented	1 900 000	1 100 000
Net cost per life saved	7 110 000	4 120 000
Net cost per life-year gained	810 000	470 000

*These values differ from those that would be calculated directly from Table VI: they were calculated from unrounded data for Table VI and then rounded to the nearest $10 000.

probabilities would increase or decrease costs and outcomes in rough proportion to each other. For example, adopting an upper-limit estimate of the probability of responding to a mailed reminder would give rise to similar proportional increases in both program costs and outcomes. Health care costs averted would be increased, but since they are small in relation to program costs the ratio of net cost to clinical outcomes would not change substantially.

It can be argued that other possible programs to increase tetanus vaccination coverage may be cost-effective by virtue of lower program costs. However, this notion is not credible in the absence of changes in health care delivery, as mailed reminders accounted for only 13% of the estimated program costs.

Nor should it be assumed that vaccination done in public clinics would be sufficiently less expensive than the existing program to render tetanus vaccination cost-effective. In an analysis of the 1976–77 US "swine influenza" vaccination program Schoenbaum, McNeil and Kavet[49] noted that the administration cost per person vaccinated by private physicians had previously been estimated at $2.26.[50] On the basis of their collective experience they estimated that administration costs in public clinics would be $0.50 per person in the target group or approximately $0.85 per person vaccinated in a program directed toward the elderly and people at high risk. In a subsequent examination of swine influenza vaccination in Illinois public clinics Koplin and associates[51] found actual administrative costs to be $2.15 per person vaccinated. Although these results do not establish cost equivalence of public and family practice vaccination programs, they show that cost differences must be investigated rather than assumed.

Simultaneous administration of tetanus toxoid and influenza vaccine could conceivably result in reduced tetanus vaccination costs and enhanced cost-effectiveness. (Annual influenza vaccination is currently recommended for all elderly people by the US and Canadian national advisory committees on immunization[52,53] and the Canadian Task Force on the Periodic Health Examination.[4]) However, such a linkage could only be partial because approximately half of those who give a history of incomplete tetanus vaccination will report never having received tetanus toxoid and will require a full primary vaccination series: two doses of adsorbed toxoid given at least 1 month apart and a third dose given 6 to 12 months later. The remainder will require either one or two injections to complete their primary vaccination series. The potential effect of linking influenza and tetanus vaccination is substantially limited by the current low rate of influenza vaccination, estimated at 20% per year among elderly North Americans.[53–55] In addition, the acceptability to patients of such a linkage remains uncertain, given the lack of reports in this area. Would elderly people accept simultaneous administration of two vaccines, each carrying a risk of local and systemic adverse reactions? Would the prospect of two injections frighten off older people who might have been willing to accept one or the other by itself? Even if successful, linking influenza and tetanus vaccination could not be expected to result in enough cost savings to produce attractive cost-effectiveness ratios for primary tetanus vaccination.

We limited our evaluation to primary tetanus vaccination. Our findings cannot be applied automatically to maintenance of immunity through booster doses of toxoid. Given the rarity of tetanus, the value of routine as opposed to wound-related booster injections is uncertain. What seems clear, however, is that efforts to increase primary tetanus vaccination coverage among elderly Canadians would be a questionable use of health care resources.

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