Child Safety Seats on Airplanes:
a Lesson in the Folly of Casual Health Policy Recommendations

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Abstract

Background: When relative risk calculations show a potential for improving health outcomes, it is tempting to recommend action. But health research that shows a large relative risk is not sufficient information for policy decision making. Even with large relative risk, the potential absolute benefit might be small. Furthermore, policy action can never be based on benefits alone, and so costs must be considered before an action is proposed. In addition, the proposed policy must be analyzed to determine likely actual results, and its impact on other policies should be considered.

Methods: To illustrate that policy analysis of public health can and should be done, we analyze the 2001 American Academy of Pediatrics recommendation that babies on commercial aircraft be required to be restrained in a purchased seat, rather than being carried on someone's lap, to protect them from crashes or turbulence. We estimate the aforementioned measures of the policy – absolute benefit, costs, and probable actual results – using existing transportation statistics, economic analyses, and rough estimates of a few key values.

Results: The proposed policy offers extremely small potential benefit at high cost. Furthermore, it turns out that the cost of the extra airplane ticket would cause many families to drive instead of flying, resulting in a net increase in deaths and injuries to babies (not to mention other family members). The more general result is that this type of analysis can and should be performed before policy recommendations are made, because it often demonstrates results that are strikingly different than a naive assessment.

Conclusions: Simply describing a policy and assuming it will accomplish what is intended can lead to terrible policy recommendations. Health researchers should participate in formulating health promoting policies. If they do not, it is likely that no policy analysis will ever be conducted that is informed by their health research knowledge. But good policy recommendations must be based on policy analysis sciences in addition to health research. Recommendations should never be made based on relative risks alone.

Background

Epidemiologic studies do not provide sufficient information for policy decisions, and so valid policy recommendations cannot follow immediately from study results. A study can show there is some benefit that might result from a policy. But almost any proposed policy produces some benefit for someone. Action should not be considered until there is some estimate of costs and how they compare to absolute benefits.

With the exception of relatively simple interventions, like acute medical care, health research studies seldom estimate the cost of the potential intervention or even the absolute benefits. (Knowing the change in relative risk that will result from an intervention is not informative by itself. We need to calculate *absolute* benefits by multiplying the change in relative risk by the baseline incidence, and then by the at-risk population.) It is even rarer to see an analysis of how much of the potential benefit could realistically be achieved, since an analysis that is implicitly based on moving everyone into the lowest risk group is usually fanciful.(1) Furthermore, when specific actions are called for, the actual results of those actions (as opposed to the intended or hoped-for results) must be determined.

In short, calls to action in health research reports are not supported by the research. Policy recommendations require scientific research, from economics and related fields, that is very rarely part of a health research study. It is almost always a bad idea to tack policy suggestions onto the end of a research paper. This admonition is sometimes misunderstood as a suggestion that policy implications are unimportant, but it is actually quite the opposite: policy recommendations are far too important and complicated to be blithely made without the necessary research.

Methods

We illustrate and expand upon these points using a particularly glaring example of poorly reasoned policy recommendations in the health literature, the American Academy of Pediatrics' (AAP) recommendation that airline regulations be changed to require babies to be secured in safety seats, rather than held on adults' laps. This recommendation is a perfect illustration of the many ways in which policy recommendations based on only relative risk can go awry.

In 2001, AAP released a series of publications (press releases, policy statements, and an article in *Pediatrics*, authored by the Committee on Injury and Poison Prevention, chaired by MJ Bull (2)) calling for a new regulation. Based on epidemiologic evidence that unrestrained small children ("lap babies") are at greater risk of injury and death in survivable plane crashes and violent turbulence (with a relative risk as high as about 10 compared to seatbelted adults), AAP called for federal regulations to require parents to buy tickets for babies on commercial flights so they could be placed in a safety seat in their own seat. Currently, babies can fly for free when held on an adult's lap.

To analyze the implication and wisdom of this policy, we looked at a series of consideration that should be included in a policy recommendation. For each of these, we considered its particular implications for the proffered policy recommendation.

We calculated the absolute risk, or the total burden of the risk factor that is supposed to be reduced, by applying appropriate arithmetic to aggregate descriptive statistics for the exposed population (babies on planes), baseline risk (for adult passengers), and relative risk. We calculated approximate real resource cost per baby saved *in the absence of changes in consumer behavior* (see below) by estimating the cost of displacing another passenger from a seat and multiplying by the number needed to "treat" to save one baby. We identified possible addition opportunity costs, but did not attempt to quantify them.

In order to assess the actual effects of the policy we identified an alternative intervention as a baseline for comparison. Finally, we estimated the actual consequences of the proposed policy by estimating the increased cost of flying for a family and, using economic estimates of the response to price change, the effect the resulting increase in car travel. We then multiplied this by rates of fatality and serious injury for car travel to estimate the net health consequences of the policy.

We did not attempt to carry out the standard cost-effectiveness or cost-benefit analysis (though we do a partial cost-effectiveness calculation to provide context for total costs). This is not just because the benefits turn out to be negative, rendering such analysis moot, but also because the goal of the analysis was to emphasize how various factors each should be considered in making policy recommendations, as opposed to simply carrying out a single textbook calculation.

Results

Absolute Population Risk

High relative risk is neither necessary nor sufficient for a health risk to be substantial. A risk ratio of 1.1 is substantial if it is for heart attacks in men over 60. But the absolute risk is quite small from even a 10-fold increase from survivable plane crashes, hard landings, and severe turbulence (for convenience, we label the collection of such survivable events "incidents," excluding crashes that kill everyone or almost everyone on board). Apparently no specific statistics are kept on air travel fatalities by age, but numbers easily available from the National Transportation Safety Board (10.8 billion enplanements (3) and 398 fatalities from incidents (4) on U.S. commercial air carriers 1982-2002) and from the *Pediatrics* paper itself (4.6 million U.S. enplanements per year are children under 2; relative risk for unrestrained baby of about 10) yield a bit more than 1 baby death in a survivable incident per year. The mortality statistics exclude 19 crashes where everyone was killed (and thus restraints could not have mattered), plus 4 accidents with <5 survivors each (where restraints were very unlikely to matter). The calculation uses a very conservative (i.e., high) estimate for the relative risk, since Bull et al. claim the figure is 5.9 in the United States and 9.6 worldwide.

For adults, the rate of serious injuries from air travel is close to the rate of deaths in survivable accidents; lacking better information, we can approximate the rate for babies to follow this pattern.

(As a reality check, it should be clear that the relative risk of death used is almost certainly higher than the true value. Even excluding those accidents with <5 survivors, 16% of the passengers

died in survivable crashes. Thus, since there is a ceiling of 100%, it is only barely mathematically possible for the relative risk to be 5.9, let alone greater. However, since the relative risk of serious injury might be higher from non-fatality-causing incidents, we will stick with 10 for the conservative estimate.)

The tendency to think only in terms of relative risks tends to obscure the information that could be gained by simply counting: In this case counting tells us that the potential benefits are extremely small. The maximum potential reduction in risk is roughly one extra death and one serious injury per year, comparing the extreme cases of no babies ever in restraints on planes versus all babies in restraints all the time they are on planes. This comparison overstates, probably substantially, the actual potential for improvement in the manner observed by Poole (1); many babies are already restrained and there would not be 100% compliance so the maximum theoretical benefit could never be achieved.

The small absolute risk does not mean that no policy intervention is warranted – after all, a particular guardrail installed on a road or walkway probably will save less than one life ever, but it still might be considered well worth its cost. But before a novel and potentially costly intervention is considered, it is worth asking "is reducing this risk really worth the effort, given that nothing comes without a cost?" In this case, even without attempting to estimate the cost, it is hard to imagine that it could be.

Direct Cost

Almost every proposed policy has benefits, but every policy action has costs. Every government program makes someone better off, but costs every taxpayer a bit. Every improvement in the health insurance coverage increases the costs. More research on a topic will inevitably tell us more, but is not free.(5) Only when costs and benefits are considered together can we decide if the net benefit is positive.

The costs of the AAP's proposed policy include the resulting changes in behavior (families not taking airplane trips because of the increased cost from the additional ticket), the indirect costs of crowding out other policies that might provide health benefits, and the direct costs of the action itself. The first two of these are taken up below, and it turns out that the first renders all the others moot, but for illustrative purposes, we will start by considering the direct costs. Bull et al. imply they believe that families will buy the extra seat rather than changing their behavior. Pretending this is plausible for the moment, we can calculate the total cost per baby saved.

It turns out that the naive measure of cost, the actual fares paid by consumers for the extra seats (whether flights are full or not) is not a cost, but a *transfer* to the airlines. (The economics jargon, "transfer," refers to movements of wealth that do not involve any using up of *real resources* (anything people directly value, such as goods or people's time), and is thus not a net social cost. Recognizing that financial transfers are not real social costs is one of the many subtleties of policy sciences.) While we might consider a transfer from young families to industry as a net negative (though, given recent airline bailouts and changes to the tax policy, the U.S. government seems to be promoting it), but we still cannot treat the entire amount transferred as a measure of the real cost.

The major real resource cost is other travelers' missed or delayed travel because a flight is full and a seat is taken up by a would-have-been lap baby (if the flight is not full, the use of the seat creates no real resource cost). To our knowledge, there is no publically available estimate of how much the average passenger loses when he is not able to buy a ticket on a particular flight. But given the high price airlines are able to charge for the last seats on a flight (typically hundreds of dollars more than other seats sold the same period in advance) it seems to be substantial. Based on this and common knowledge of air travelers' wealth and preferences, it seems that $100 is a reasonable estimate of how much the displaced potential travelers would have paid to be on the particular flight (in addition to the purchase price of the ticket). This willingness to pay is the cost of using up that seat.

To determine how many people lose their seat for each baby saved, we need to calculate a value equivalent to the number needed to treat and estimate how many such "treatments" cost someone a seat. The risk of death for an adult in an incident is one per 27 million enplanements and the risk of serious injury is almost exactly the same.(3;4) Thus, if we assuming a relative risk of 10 and that a safety seat eliminates all excess risk, about 1.4 million babies must be "treated" (moved into safety seats) to eliminate one serious injury or death. Estimating that half of the extra seats filled by babies are on full flights,(6) the total real resource costs per death or serious injury averted is about $70 million, which is more than an order of magnitude higher than what is usually considered a cost-effective intervention.

The rough estimates used in this calculation should not be taken to mean that economics-based policy analysis is less exact than the underlying health research. These estimates are sufficient to make it clear that the costs are excessive. While it would be possible to make them much more precise, it would not change the basic result. Furthermore, these estimates are probably no less precise than most health research results, even though the latter are typically reported in ways that imply great precision, such as Bull et al. reporting the relative risk for babies of 9.6, based on only a few observations per year, rather than rounding to 10 as we do. (See Phillips and LaPole (7) for further discussion of implied over-precision in health research.)

Political and Opportunity Costs

Real resource costs are usually the best measure of social costs. But since total political will and policy-making resources are limited, costs also include crowding out other policies or actions. Every time people see another warning label or hear another behavioral recommendation, interventions that might naively be considered to be free, the impacts of all warning labels or recommendations are reduced. Every time health advocates call for government action, they use up some of the popular will for improving health at the cost of money or freedom. Every time a physician is asked to spend time doing something during an office visit (as Bull et al. recommend to pediatricians), something else remains undone.

These costs are difficult to quantify, but should not be ignored. The AAP is very aggressive in making new recommendations, and as a result they have a backlog of many more than can ever be carried out given the total resources available for child health and safety advocacy. If child health advocates pursued this policy, there would be less attention available for other policy advocacy, education, and other efforts. Given the very small total potential benefits of the

proposed policy, it seems like that the displaced alternative would offer more potential benefits.

Comparing the Right Alternatives

Policy and other decisions should always be compared to the best other option available. A much cheaper alternative to the proposed policy would be to require any unsold empty seats be used to put would-be lap babies in safety seats. Bull et al. identify this alternative and it already happens informally. Costs are largely limited to airlines reprogramming their seat assignment systems to keep remaining empty seats next to adults with lap babies, and the stocking of extra safety seats in airports for the occasional travelers who do not already have a car seat.

Since this policy would protect many of the babies with a relatively small cost per enplanement, it should be the alternative on which the net costs and benefits of the more restrictive policy are based (though the low total absolute benefits still might not justify the costs). To make any other comparison would be similarly misleading to showing a new therapy is more effective than a non-therapeutic placebo when there is an existing effective therapy.

Actual Consequences

When a policy recommendation goes beyond a vague call to action ("steps should be taken....") and includes a specific intervention, it is necessary to assess the actual, rather than intended, consequences. Requiring families to purchase an additional seat would not just put babies in safety seats. It would increase families' total cost of flying, which would cause many to opt for the much more dangerous option of driving. Bull et al. assert "no data support this argument" (2) (p.1218), but this claim is absurd. The science of economics shows that when the price of something goes up, people always (for all practical purposes) consume less of that good and more of substitute goods. This fact – well known to any policy researcher – is sufficient by itself to invalidate the assertion. Furthermore, we can make a fairly good quantification of this using publically available data.

Consider a family of two adults, one older child, and one baby. Requiring the purchase of a seat for the baby would increase the cost of travel by up to 33%. (This assumes she would have been a lap baby; if the family would have purchased a seat anyway, the policy has no consequence for them.) Assume the airlines give a 20% discount (as they often do now), lowering the increase to 27%. The best estimates in the literature are summarized in a Report of the Secretary of Transportation to the United States Congress.(8) They suggest that families have a *price elasticity* of –1.75 for flying. That is, for each 1% price increase, there is a 1.75% decrease in demand for flying. So, for our family, the chance of flying is calculated as (1.75)(27%)=47%. For the remaining 53%, the same source estimates that 70% would drive, an average of 500 miles (presenting new risk) and the rest would forgo their trip (a cost).

To assess the total benefits of the proposed policy, we observe that an injury/death is averted only when four conditions are met:

- The family chooses to fly, despite the price increase. Probability = 0.47

- There is an incident that would have injured or killed the baby. Probability =

1 / 1.4 million

- The flight would not have been full (else the inexpensive alternative policy would have the same effect). Probability = ½

- The safety seat would have saved the baby. If we assume the seat would reduce the baby's risk to just that of a restrained adult, the relative risk of 10 gives probability = .9

Multiplying out these probabilities yields about 0.1 deaths and 0.1 injuries from incidents averted per million flights that would have been made by babies before the price increase. (Recall, for scale, there are about 5 million baby enplanements per year.)

On the health cost side, we have the extra deaths and injuries from driving. At about 1.4 serious injuries and .014 deaths per million passenger miles,(9) with 0.7 of the families who do not fly making a car trip of an average of 500 miles, there are an additional 1.3 baby deaths and 140 serious injuries per million flights that would have been made in the absence of the new policy. (This is net of the comparatively inconsequential risks from both survivable and non-survivable airplane accidents avoided by not making the flights.) Obviously this dwarfs the total benefits without even considering the 4 deaths and 400 injuries for other family members who also suffer the additional risk from driving compared to flying, and the additional risks to other motorists from having one additional car on the road.

Since the health costs are several orders of magnitude higher than the health benefits, the finding is not very sensitive to changes in any of the numbers in the calculation. (This is actually a common occurrence in policy analysis. Even a back-of-the-envelope calculation can often be enough to show that a policy is clearly good or bad, a useful lesson in itself.) For example, returning to Bull et al.'s claim that few families would change their behavior, we have shown previously,(10) using slightly different assumptions, that if only 1% of all families forgo air travel because of the price increase, there is a tiny net reduction in baby deaths (less than 0.1 per million enplanements), but only at the expense of almost twice that many extra deaths among other family members and more than 10 times that many serious injuries. If as few as 3% of families forgo air travel due to the extra cost, a number that is unimaginably low, there will be a net increase in deaths for babies, let alone other family members.

We could add in the cost of foregone trips for roughly 15% of families, the real resource costs of the additional miles driven, and the net impact on taking up and freeing up seats on airplanes. If the health benefits were positive, we might want to weigh them against such non-health costs (the standard cost-effectiveness exercise), but since the health benefits are negative, there is no reason to do this. (We previously presented decision-tree that calculates the various costs.(10)) {NOTE TO EDITORS/REVIEWERS: WE COULD INCLUDE AN UPDATED VERSION OF THE TREE AS A FIGURE OR ONLINE SUPPLEMENT TO THE ARTICLE IF IT WOULD BE CONSIDERED USEFUL.}

Conclusions

The conclusion that the AAP's proposed policy is a bad idea should be sufficiently obvious to not be worth elaborating upon. Indeed, there is probably little chance that transportation policy makers would seriously consider implementing this policy; experts in that area are certainly aware of the small total population risk, and understand that price changes create incentives and that driving is many times as dangerous as flying. It is the more general lesson that worth emphasizing: Simply describing a policy and assuming it will accomplish what we hope can result in high costs compared to benefits, or even no benefits at all.

This does not imply that health researchers should avoid addressing policy issues. This paper should demonstrate that such analysis is not prohibitively difficult. Our calculation was originally conducted as a back-of-the-envelope exercise in a health policy and ethics class. We used only the information in the original call for policy action, reasonable guesses about most numbers, and only one piece of outside data (the death rate per automobile passenger mile). But to analyze policy issues appropriately, researchers need to acquire or access expertise in policy sciences. To present the results requires a few thousand words rather than a sentence or two at the end of research report.

Researchers should not advocate for action without researching the minimum cost of an intervention, calculating the maximum theoretical (absolute) benefits, and seriously considering possible unintended consequences. Doing any one of these correctly would probably have prevented the unfortunate recommendation critiqued here.

But health researchers should not let these added challenges dissuade them from being the engines of policy advocacy. There are few people so invested in figuring out how to improve a certain aspect of people's health as the epidemiologists researching the relevant exposures or diseases. That enthusiasm and expertise should not be excluded from policy discussions. The lesson is not to avoid policy recommendations because they are not trivial, but to take the steps to perform good policy analysis. Health policy would be well served by more collaboration between epidemiologists and policy researchers, with expertise in economics and related fields, and by the publication of more policy analyses in the health research literature. There is little point in doing applied research without figuring out how to apply it, and if health researchers do not do so, who will?

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