

Editorial

The tragedy of the commons in antimicrobial chemotherapy

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In 1968, Garrett Hardin published (and extended 30 years later) an extremely influential reflection of wide, interdisciplinary interest entitled *The Tragedy of the Commons* (1, 2). The commons refers to any type of collectively owned property of limited size. The tragedy should be understood as a process leading to an unhappy event from which there is no escape, in the sense used by Whitehead (3). In his work, Hardin provided a metaphorical description of the tragedy (1): "Picture a pasture open to all. It is expected that each herdsman will try to keep as many cattle as possible in the commons. Such arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the number of both man and beast well below the carrying capacity of the land." Nevertheless, in more civilized times, in which wars and diseases are minimized by advanced social structures and widespread vaccination, the number of animals should reach a limit beyond which the optimal (maximal) amount of food per capita starts to diminish. This is translated into less meat per capita to sell, and less money per animal obtained by every herdsman. To compensate for this loss in income, one of the herdsmen may recur to the solution of adding one more animal to his herd. This would be immediately reflected in a personal net income, even greater than the

previous level. Clearly this solution would be detrimental to other owners, but as there are many of them, the loss would be shared by the whole community and would therefore be minimal (and may go unnoticed) for each individual herdsman. A tragedy may occur when the successful owner starts to add more animals to his herd, and/or when the other owners start to detect a loss in income and take on an identical strategy of adding new animals. The commons would be overgrazed and the tragedy would begin to take shape. There would not be sufficient food for the herds in the commons. Paradoxically, what would have caused the problem (the number of animals on a limited common pasture) would be used to find a solution.

This parable generally illustrates how commonly owned natural resources can incur extensive devastation if they are subjected to limitless exploitation. Many examples of the tragedy of the commons are available (4). Some of them were provided by Hardin himself (1). Because fishing in the "common seas" is less and less productive, the number of fishing boats (and the fishing technology) increases, and species after species of fish become closer to extinction. Because a common national park needs a growing number of expensive public services, the number of visitors allowed in is increased, and consequently the nature that attracts

the visitors to the parks gradually erodes, so that after a certain period of time, the park is no longer of interest to tourists. Hardin also identified the tragedy of the commons in problems related to communal pollution: "The rational man finds that his share of the costs of the wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them." As others will share his attitude, pollution will become so bad that the common wastes will in turn pollute the production of the undertakings of rational men.

In Spain, the widely socialized organization of public medical care has been of immense benefit to the health of citizens during the last half century. However, this has not occurred without some adverse effects. Pharmaceuticals, and particularly drugs that are considered to provide an "immediate benefit" essentially for free, such as antibiotics, have been considered to be an inexhaustible common, both for prescribers and the general public. As a result there has been an overconsumption of antibiotics, with an ensuing net increase in antibiotic resistance and a likely reduction in the therapeutic efficacy of the drugs (5, 6). This situation is typical of the "tragedy of the commons". In a highly liberal society, the possible individual benefits are awarded immediately, assuming that the associated social damages will be shared by so many people that the increase in individual risk will be negligible in practice. When significant increases in antibiotic resistance were detected, and the use of certain drugs could have been challenged, the pharmaceutical companies reacted against the possible reduction in profits by launching new variants of drugs or higher doses of old drugs into the commons. Unfortunately, many of these drugs did not replace the others, nor did they differ enough from them to prevent the escalation of antibiotic resistance. The overall result was that in order to reduce the negative effects of resistance on the health of both patients and companies, more and more grams of antibiotics were placed in the commons. In a simplified but symbolic way, it could be said that each new gram of antibiotic launched into the common reduced the efficacy of the next gram by a certain percentage. The paradox was established: miracle drugs were destroying the miracle (7). The tragedy was taking shape.

The tragedy of the commons is the problem involved in sustaining a public resource that everyone is free to overuse. This is a general problem of the structure of our Western society. In our global but still pluralistic society, new ways of promotion of individual freedom or independence (the "flaggy syndrome") tend to be rapidly embraced, whereas those that appear to centralize power and authority are either attacked outright, or accepted only after con-

tentious debates (8). In antimicrobial chemotherapy, the policies recommending stringent use of guidelines or even the obligation to restrict prescription only to antibiotics forming part of closed lists, have frequently been considered incompatible with the medical freedom of prescribing. The tragedy is a tragedy because there is no clear solution to the problem if the terms of the equation are not modified.

Nevertheless, it has been recently proposed that reputation may help to solve the tragedy of the commons (9). The solution (derived from game theories) implies that the revenues of individual herdsmen depend not only on the animals but also on other activities involving interactions with the other herdsmen in other situations. If the main effect of acquiring more riches at the expense of the commons may sully the reputation of the herdsman for any other activity, he may be less inclined to overgraze the field. There are several good examples of this regulatory effect in antimicrobial chemotherapy. Doctors that greatly overprescribe antibiotics may be jeopardizing their reputation with better informed medical colleagues. The same may be true for consumers or pharmacists. Obviously, different cultural backgrounds may have a somewhat different approach to linking social reputation with acceptance of the rules. This may be of importance when analyzing the patterns of antibiotic consumption in different geographical areas (5). Even considering these difficulties, education remains critical for preventing overuse of antibiotics, since people not adhering to norms for rational use may be identified by others and risk their reputation. Intranational and international surveillance programs of antibiotic consumption and antibiotic resistance (*e.g.*, the European Surveillance of Antibiotic Consumption and the European Antimicrobial Resistance Surveillance System of the European Union) are critical to disseminate comparative data and consequently establish levels of reputation. We should emphasize that inappropriate demand or prescription of antibiotics (5) should diminish reputation. There is no doubt that the excellent reputation that the efficiency of the public health services in Spain has earned is somewhat spoiled in the international arena by the obvious excess in the use of antimicrobial agents. Institutional intervention may help to prevent or delay all types of tragedy of the commons (10).

Interestingly, several leading pharmaceutical companies marketing antibiotics seem to have simultaneously discovered on their own – before reading Milinski *et al.* (9) – that in order to maintain their reputation (which is obviously required to sell products in this and other fields) they need to help establish policies of "appropriate prescribing" behavior. Despite the fact that this probably stems from their looking out for their own interest, this is a most welcome

trend as it may increase the reputation of appropriate use of antibiotics and reduce harm in the commons. A final critical reflection which all of the players in antibiotic production, prescription and consumption should have in mind is that we are acting on a real commons. The microbial organisms associated with the human realm constitute a common patrimony of mankind, and we all have a shared responsibility in ensuring that the common remains as productive as possible for human health and welfare. Those who actively support this view will earn the reputation of the commons.

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