

case of applied research is of course different). Supporting good people, and judging the opportunities in different fields by their ability to attract the best students, might be a better policy.

Second, basic research is not only in jeopardy from would-be planners because its benefits are unpredictable, but also tends to be in the firing line when governments wish to cut spending on research because the benefits are so long-term. 'The Endless Frontier', Vannevar Bush's visionary 1945 study, which set the framework for subsequent support of science in the US, contains a warning by a committee that included I. I. Rabi, professor of physics at Columbia, Oliver Buckley, President of Bell Labs, and

Edwin Lane, President of Polaroid that 'Under pressure for immediate results, and unless deliberate policies are set up to guard against it, applied research invariably drives out pure'. We physicists have a duty to urge that such policies are adopted and to explain the use of science in general, and physics in particular, to the policy makers and the general public.

1. Brian Appleyard, *Understanding the Present, Science and the Soul of Modern Man*, Picador, 1992.
2. See Kay, J. A. and Llewellyn Smith, C. H., *Fiscal Studies*, vol. 6, no. 3, 1985, where the fact that fundamental science is a

public good is also discussed at length.

3. Casimir, H. G. B., contribution to Symposium on Technology and World Trade, National Bureau of Standards, US Department of Commerce, 16 November 1966.
4. Quoted on p. 198 of *The Life of Sir J. J. Thomson*, Lord Rayleigh, Cambridge University Press, 1942.
5. Kalmus, P. I. P., *Phys. Bull.*, 1985, 36, 168.

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Appropriate research: unnecessary injections in India

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India has many scientists, but their impact on the world scientific literature is not in proportion to their numbers. Yet Indian scientists might investigate many problems which do not, at least initially, need elaborate equipment or even outside funding. Such a problem might be the effect of injections given by doctors or other people, on the health and wealth of their patients.

Everyone knows that injections are immensely popular among all classes in the Indian subcontinent, but there is scarcely anything in the medical and little in the anthropological literature. On injections given to babies and small children, there is virtually no literature although, for instance, injection abscesses are common. The Indian subcontinent is huge, it hosts diverse religions, philosophies, environments and social and hygienic conditions. It is scarcely possible to make generalizations from the scattered papers which have been published. How many injections were given by whom, to whom? What is injected, for what conditions? How many of the injections are medically unnecessary and how many, necessary and unnecessary, might have iatrogenic consequences? What are the financial consequences of payments for injections

by the poor who have the poorest health and nutrition and therefore may receive more injections? Any competent scientist could investigate these questions. Are they worth asking?

Unless the syringe and needle are sterile, bacteria may be injected and cause an infection, either locally as an abscess or systemically. A syringe or needle which is reused without sterilization may transfer the parasites of filariasis and malaria, hepatitis viruses (e.g. HBV), the human immunodeficiency virus (HIV) and the spirochaetes of syphilis from one person to the next. The material injected may be antigenic, poisonous, deleterious or just plain useless, perhaps even only dirty water. The Essential Drugs Programme of WHO has been concerned with drugs but not with their administration.

An infection with HBV or HIV will have a long incubation before disease as hepatitis or AIDS is apparent so that there will be no obvious link to an injection months or years earlier. However, twice as many patients receiving repeated injections had antibodies against hepatitis B virus as controls¹. It is sad that unsuspecting patients can be misled: even an injection abscess may be explained:

'You had a poison all through your body. My injection caused the poison to be drawn into the injection site, leaving your body cleansed. Now if you go to the hospital, the doctor will be able to draw off all the poison'².

Health workers, doctors and mothers have all noticed that often a child who has received an injection for fever, will develop paralysis in the leg injected. When asked, health workers responded by saying: 'the leg was going to be paralysed and the doctor injected a medicine, but the illness was too strong and the medicine was unable to prevent the paralysis.' Paralytic poliomyelitis following injections was first reported in 1914 in children with congenital syphilis treated with Ehrlich's magic bullet. Other reports from tropical countries continued until 1950 when provocation poliomyelitis was recognized following injections of inflammatory materials in Britain and Australia³. If a child was incubating a wild poliovirus infection, an intramuscular injection of inflammatory material increased the risk of the child developing paralysis. In India doctors have noticed the coincidence of paralysis following 24 to 48 hours after an injection but have been unable to show that the paralysis was causal.

An analysis of the case-histories of 262 children with acute paralytic poliomyelitis in Pondicherry showed that about 75% had received one or more unnecessary injections just before paralysis. These injections which included antihistamines, prostigmine, gentamycin, terramycin, penicillins, other antibiotics and vitamin B complexes, were given for fever and diarrhoea. There was little clinical justification either for the drugs or the giving by injection. Some children received six injections in a single day; others were given injections for several days after limbs were paralysed after a first injection. In children without injections, the chance of paralysis in left and right legs was equal. Injections changed the pattern of paralysis in the uninjected as well as in the injected limb. The number of legs paralysed and the severity of paralysis were increased by injections. Death in the acute illness was more likely following injections and recovery from muscle paralysis seemed less likely. This is very strong evidence that nearly three quarters of the children suffered unnecessary or more severe paralysis because of unnecessary injections⁴.

The children who had received un-

necessary injections were incubating a poliovirus infection in which wild poliovirus had already reached the spinal cord and was causing the fever. In those children whose legs were already programmed for paralysis, the paralysis was made more severe by injections. In other children the amount of virus which would have reached the spinal cord was sufficient only to produce a non-paralytic attack: in these children the injection triggered paralysis. The increase in severity and incidence of paralysis has been called aggravation poliomyelitis and is similar to the previously known severity of polio after strenuous activity. Altogether nearly one half of the children had more severe paralysis because of the unnecessary injections. Nearly one third more would not have had paralysis without the unnecessary injections.

We estimate that in the ten years from 1980, as many as 600,000 Indian children may have been paralysed by unnecessary injections and another 900,000 may have suffered more severe paralysis.

The immunization programmes may reduce the prevalence of paralytic poliomyelitis but in times of war, civil

unrest, floods, typhoons and earthquakes, the first casualty is the cold chain required for oral polio vaccine (OPV). Children become refugees in camps where disease is rampant. Injections are given and children are paralysed⁵. Inappropriate injections are an appropriate subject for investigation and intervention by Indian scientists.

1. Rao, G. G. and Shahi, M., *Br. Med. J.*, 1987, **295**, 1281.
2. Wyatt, H. V., *Soc. Sci. Med.*, 1992, **35**, 795-798.
3. Wyatt, H. V., in *Injections* (ed. Bloem, M.), Vrije Universiteit University Press, Amsterdam, in press.
4. Wyatt, H. V., Mahadevan, S. and Srinivasan, S., *Trans. R. Soc. Trop. Med. Hyg.*, 1992, **88**, 546-549.
5. Greetham, C. J., *Physiotherapy*, 1991, **77**, 421-422.

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SCIENTIFIC CORRESPONDENCE

Remote sensing

In continuation of my rejoinder and the reply of Joshi¹, I would like to place the following points which need our readers attention:

1. The Ujjain district is well known for its basaltic plateau country and nowhere are the Vindhyan rocks exposed in this district. Joshi identifies the Vindhyan of Dhar district as that of the Ujjain district in a global context. Is it justified to identify Dhar district as Ujjain district and to report the Vindhyan rocks in Ujjain district, even in a global context? The caption given for plate 20 needs necessary corrections².
2. It is true that towards the SE margin, the Aravalli Supergroup of rocks are

relatively unmetamorphosed. However, it does not mean that they are the sandstones and shales. Even the book edited by Roy³, which has been referred to by Joshi also, does not indicate the presence of sandstone anywhere in the Aravalli Supergroup sequence. These relatively unmetamorphosed rocks are represented by the slates, phyllites and quartzites including dolomites.

3. The caption² given for the plate 23 describes 'the unmetamorphosed Aravalli Sandstone'. In his reply, everywhere Joshi has described 'these sandstones' as the 'basal quartzites' of the Lower Aravalli Supergroup. It is unclear whether the caption is correct or the reply!
4. The pre-Vindhyan quartzites present in the Bundi area, which also point to the precise location of the Great

Boundary fault of Rajasthan (GBF) in this area, has been regarded as the Datunda quartzites⁴. It appears as patches and does not form continuous homoclinal ridges. The other pre-Vindhyan rocks (Aravalli Supergroup of Roy³ *op. cit.*) present in the area are the slates, phyllites and dolomitic limestones—none of these form strike ridges.

5. The two stages of folding have been well documented in the Vindhyan rocks of the Chittaurgarh area⁵ and hence, simply the presence of two stages of folding does not assign any age to the rocks of the Bundi area.
6. Several published literatures⁶⁻¹² clearly indicate that the homoclinal ridges and intervening valleys, extending from west of Bundi city up to Indargarh in a ENE-WSW trend, are the geomorphic features deve-