



Expanded Programme on Immunization
RESEARCH AND DEVELOPMENT
STATUS REPORT : BIOTECHNOLOGY
March 1988



Progress since the September statement on activities and plans for research and development in the field of biotechnology for the EPI is reported under the headings listed below:

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1. EPITECH ; IMPROVEMENT OF INJECTION TECHNOLOGIES

Work is proceeding in the following four activity areas:

- 1.1 Reusable syringes and sterilization
- 1.2 Auto-destruct disposable syringes
- 1.3 Pre-filled injection devices
- 1.4 Low cost jet injectors

These alternative injection technologies are listed in ascending order of cost, today, and descending order of risk of transmission of Hepatitis and HIV. The aim has been to develop all four technologies to a point where the choice can be made by each country according to their perception of risk versus cost.

1.1 Reusable syringes and sterilization

Two reusable syringe manufacturers have are now in the process of producing samples of the new 0.5ml syringes for testing. A study has been made of the causes of premature failure of plastic 0.1ml syringes in the field and three major factors have been identified:

- poor quality moulding
- inadequate materials quality control
- effects of hard water deposits

A study on the effectiveness of hard water pads to reduce the effects of hard water has shown that the pad must be raised to the surface of the surface of the water in order to achieve full performance.

Needles with reusable plastic hubs have been developed and independently tested with successful results. Field trials are now indicated and purchasing is in progress for this purpose.

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Work is proposed or in progress on a range of activities designed to reduce the energy required for sterilization. Microwave generation of steam is being considered for utilization of photovoltaic energy and high efficiency wood stoves developed for the Sahel are to be evaluated. Three types of direct solar steam generators which have performed well in conjunction with standard EPI sterilizers are to be evaluated in Burkina Faso, India and a third country.

Removable sterilizer drums, which were developed by a company in Italy and tested successfully in 1987, are being purchased and are to be tested in Indonesia. Sufficient samples will be available for tests in other countries but none have been identified so far.

A low cost (U.S\$ <1.00) plastic syringe incinerator box, to contain up to 100 syringes up to 5ml capacity with needles attached, has been developed for the destruction both of reusable and disposable syringes. The box, which will be packed flat for distribution to the disposable syringe manufacturers and direct to the field, is designed using foil technology used in protecting the U.S Minuteman missile from static electricity. This construction and a fuel stick attached to the box ensures that the syringes burn themselves after one hour, the burning plastic always remaining contained within the box.

The policy on reducing the risk of accidental needle-stick has been to investigate three levels of protection for health workers:

- sealed incinerator box without recapping the needle
- sealed incinerator box with manual recapping of the needle using only one hand
- incinerator box with automatic recapping of the needle

The marginal cost and training burden is to be evaluated in the field in relation to the reduction of risk of accidental needle stick.

1.2 Auto-destruct disposable syringes

Before they can be available to the EPI in large quantities, auto-destruct syringe concepts pass at least once through five stages of decision making:

- (i) Patent applied for; prototype available; WHO/EPI approval obtained
- (ii) Commitment of at least one manufacturer to produce
- (iii) Production and WHO quality testing of first 100 samples
- (iv) Production and field trial of 10,000 samples through UNICEF
- (v) Tooling and preparation for mass production by manufacturer.

In addition, WHO is seeking to establish agreements with all inventors and potential manufacturers which protect the interests of the public sector in developing countries prior to the products being fully developed. Such agreements have been signed with one inventor and are imminent with two others.

Today, out of a total of seven concepts recommended during the informal WHO meeting in Washington in November 1987, two are at stage (i), two are at stage two and none have completed stages (iii), (iv) and (v). One technology has not yet reached stage (i), and two others have fallen back from stage (i). This disappointing rate of progress is due to difficulties in obtaining satisfactory moulds for concepts which had only reached "proof-of-principle" prototypes at the time of the November meeting.

However, indications are that this is a temporary setback and that real progress is now under way. The earliest technology to complete stage (iii) will probably do so by May 1988. Thus field trials in which WHO will have the role of observer, could possibly begin in June.

Following field trials which are expected to last approximately one month, modifications and tooling could take a further nine months. Thus, full production cannot be anticipated before mid 1989.

1.3 Pre-filled injection devices

Six prefilled concepts were recommended during the informal WHO meeting in Washington in November 1987. In advance of the stages of development listed for the auto-destruct syringes above, all these concepts require some research and development with the collaboration of vaccine manufacturers.

Five out of the six inventors and device manufacturers are working with vaccine manufacturers to resolve questions of materials compatibility, filling and sterilization. The sixth device manufacturer is working with industry to adopt high speed industrial filling machines used in the pharmaceutical industry for vaccine filling in plastic pouches.

1.4 Low cost jet injectors

Although no set of requirements for low cost jet injectors have yet been prepared by WHO/EPI and no active solicitation has been made to the jet injector industry, two new jet injector products have been offered to WHO and UNICEF. Both products appear to be practical both for routine immunization of small numbers of infants and for mass immunization. However, only one of these (VCI, USA) meets the cost target set by WHO/EPI in September for low cost injectors of less than \$ US 200. The other injector (SICIN, Italy - tested by WHO collaboration centre, Zagreb) costs approximately \$ US 700 and therefore competes with other high cost injectors used predominantly for mass immunization.

The National Bacteriological Laboratory, Sweden, is working on a protocol to assess risks of cross infection of jet injectors. This will form part of the requirements for low cost jet injectors which is due to be prepared by the end of June 1988. An invitation will then be sent out to the jet injector industry for concepts and proposals.

WHO will seek to establish agreements with jet injector developers as for the auto-destruct syringes.

2. ENERGY MANAGEMENT FOR THE COLD CHAIN

"Energy management" encompasses a range of research and development activities towards the efficient production and storage of energy for the cold chain:

- optimizing battery storage for photovoltaic energy
- maximizing the use of ice and eutectic storage of cooling
- interpreting usable stored energy for users of PV refrigerators
- Selling surplus energy to finance the EPI
- Long term monitoring of photovoltaic systems

2.1 Optimizing battery storage for photovoltaic energy

A range of photovoltaic batteries which have been under test at the Institute of Microwave technology in Stockholm, have performed poorly. The cause is attributed to poor matching of power regulation equipment to battery characteristics and poor formulation of electrolyte solutions. The batteries were tested using the regulators and electrolytes recommended by the systems suppliers and the battery manufacturers.

Tests continue using modified electrolytes and regulation equipment.

2.2 Maximizing the use of ice and eutectic storage of cooling

Companies in France who have developed a range of chemicals which have higher melting points and potentially longer melting times than water ice have been visited and their products are to be tested, to begin with, by two major European manufacturers of ice-lined refrigerators for the cold chain. Little progress has been made, however, on experimentation with super-insulated dewars (containers with a double wall and high vacuum insulation) for the long term storage of cooling energy.

A report is overdue from UNIVALLE, Colombia on the use of foam plastic plugs to extend the cold life of vaccine carriers during the immunization session.

Work to develop an electronic control for ice-lined refrigerators which will maximize the freezing of the ice-lining while ensuring that the vaccine does not freeze has been halted since January because the contractor to Vestfrost, Denmark who is conducting the study has gone out of business.

2.3 Interpreting usable stored energy for the users

This project is in progress at UNIVALLE, Colombia and will not be complete until August 1988.

2.4 Selling surplus energy to finance the EPI

In many countries today, the EPI is one of the only public health programmes which utilize solar energy. Solar refrigerators are gradually emerging as the only choice for the cold chain in areas where fuel supplies are unreliable and of poor quality - provided that funds can be made available to cover the cost of the initial investment.

Solar energy is not the only renewable energy with a high initial cost; wind-power, water-powered electricity generation and even thermal energy are expensive to buy. On the other hand, the strength of renewable energies is in the low long term running costs which must be borne locally.

One way to spread the burden of the capital cost and share the benefits of renewable energies more widely than the EPI may be to install more energy than is required to power a refrigerator. Generally, the unit cost of renewable energies becomes lower as the power required increases, particularly at this scale.

The surplus energy could then be offered to the community in exchange for a charge to cover the costs of the EPI which cannot easily be covered by the Ministry of Health. The energy could be offered in a variety of ways including:

- rechargeable lanterns for use in the home
- community television or radio
- individual, rechargeable radios
- hot water
- ice for food preservation
- rechargeable batteries for any domestic use.
- two-way radio communications and telephone

Charges for the use of any of these facilities might, for example, finance:

- maintenance and repair of cold chain equipment or the health workers motor cycle
- fuel for the health center vehicle or motor cycle
- per diem or food supplements to the village health worker to enable him/her to spend more time on health activities
- materials and maintenance of the health center building
- maintenance of the renewable energy equipment

Auto-financing projects of this kind have been discussed with a variety of international agencies, donors and non-governmental agencies and have received an enthusiastic response. WHO/EPI now seeks countries which already have experience of auto-financing projects so that a firm project proposal can be formulated. At the same time WHO/EPI has already begun to collect information on the products available for use with photovoltaic energy apart from refrigeration.

2.5 Long term monitoring of photovoltaic systems

Ten long term monitoring instruments which were developed for EPI in 1986/87 have been tested successfully and are now in the process of being installed in Uganda, Zaire and Pakistan. The recording instruments, unattended for each six month period, are expected to give energy balance and system performance data which will permit the following analyses:

- patterns of use and abuse by users of the system
- performance of the system in different conditions of workload and external temperature
- periods of surplus energy available for other uses
- behavior of users during periods of low energy

3. OTHER AREAS OF RESEARCH & DEVELOPMENT IN THE COLD CHAIN

3.1 Thermostat for kerosene refrigerators

Work continues at UNIVALLE Colombia and Electrolux Luxembourg on this device. reports are overdue from both groups but Electrolux will present their work on 21 March.

3.2 Development of higher performance voltage regulators

A company in the United Kingdom is the first to develop voltage regulators to the new higher standard or the EPI. Their two regulators models made to meet WHO/EPI standards E7/VR1 and E7/VR2 are now under test and UNICEF will invite those short-listed during the next tender to submit samples for testing to the same protocol.

3.3 Seeking suitable small generator systems for the cold chain

Two diesel generator sets have been successfully tested and are to appear in the May 1988 edition of the WHO/EPI Product Information Sheets.

3.4 Studying light motorcycle transport for the periphery

Twenty-three countries have been approached regarding this study but, after four months, only one has replied. Efforts will be renewed to obtain a better response during April when Mr Eric Blas will rejoin the cold chain group.

4.0 SUMMARY AND DISCUSSION

Progress since September 1987 has been disappointing on the development of auto-destruct syringes and pre-filled injection devices. Among a total of 13 proposals accepted for priority support by the November 'EPITECH' meeting, seven were syringes and six were pre-filled devices. None of these concepts yet have yielded pre-field trial samples for qualification although three syringes are very near this stage. This means that the very earliest at which quantity production could be expected for the EPI is now mid-1989 with a more realistic horizon of early 1990.

Pre-filled devices still have an estimated cost in large quantity of over \$US 0.20 per filled device of which 50% of the cost is estimated to be in the filling. At this price, the immediate immunization market will be limited to field experimentation and the future adoption of the technology within the EPI, unsure. In order to mobilize the investment needed to reach production, the risk to the investors will need to be assessed more against the development of the pre-filled device in the pharmaceutical industry in the 1990s than against the public sector vaccine market. WHO can offer encouragement in support of investment in pre-filled devices by industry but is unable to provide the commitment to large scale implementation which is indicated by our agreements with auto-destruct syringe inventors and producers.

The terms of WHO/EPI's new agreement with inventors and producers of auto-destruct syringes and the conditions declared for WHO participation of field trials are an important focus for thought and discussion. In the interests of the public sector in developing countries and to protect against the development of an unfair monopoly, the agreement is to obtain for WHO the right to have a syringe manufactured if the conditions of the agreement are violated. Additionally, and to ensure that WHO can make a sufficiently interesting proposition to industry at that time, the agreement claims for WHO rights in the private sector market of industrialized countries. Finally, the terms of the agreement seek to limit the royalties and the profits made on the syringes for use in the public sector of developing countries while leaving freedom for the recuperation of 'lost' profit or royalties from private sector sales in industrialized countries at higher prices.

Field trials of auto-destruct syringes are to be conducted only in countries with extensive use of disposables for a period of time, according to the current WHO conditions of collaboration in field trials. The purpose is to avoid influencing countries who currently use reusable equipment to turn to disposables. Countries which decide to adopt auto-destruct disposables in place of reusables in the future will probably reduce the risk unsterile syringes and needles in the EPI.

However, the risks of poor sterile technique will remain in other areas of health care unless this receives emphasis during training and supervision. If adequate attention is given to the standard of sterile technique, then reusable injection equipment remains the most cost effective choice for the EPI. A danger exists that,

by adopting disposables for the EPI, the necessary pressures for better training and supervision in sterile technique will not be brought to bear on the problem so effectively.

Finally, considering the delay likely before self-destruct disposable syringes become available and the pressure from many EPI countries to continue the use of disposables, more efforts may be needed to provide the means of destruction of disposable syringes and to study the better ways of ensuring that disposable syringes are not used more than once.

"Energy management" has become the term used to encompass a range of research and development activities aimed at the efficient production, storage and use of energy in the cold chain. Progress has been made in a variety of current activities but the focus of future plans is, at present, a proposal to sell surplus energy to finance the EPI at a local level. The proposal is still at an early stage and progress is only likely to be seen after another 6 months.

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