48367

WHO/EPI/LHIS/93.1; Distr.: General

REPORT OF 1993 TECHNET CONFERENCE

Technet is a TECHnical NETwork for logistics and Health.

This is the Third International Technet Conference of experts in logistics for health to discuss technical developments in the EPI and establish plans of action on priority issues.

This Conference was conducted for the first time via an ELECTRONIC BULLETIN BOARD, using the UNICEF-UNET electronic mail system.

Cover by DPS/ALYT - Printed by DPS/DUP

REPORT OF 1993 TECHNET CONFERENCE

LOGISTICS FOR HEALTH
INFORMATION SERIES

This document has been printed with funds kindly donated by the Government of the United Kingdom.

The *Logistics for Health Series* replaces the *Cold Chain Information Series*, published by WHO/EPI Geneva since 1978. This documentation includes guidelines for the planning and management of logistic systems for health, as well as reports of meetings, major field studies and other achievements in the development of improved equipment and logistics, not only for immunization, but also for other health interventions.

The members of Technet, a global network of logistics specialists for health, collaborate with WHO on the content and publication of this Series.

Ordering code: WHO/EPI/LHIS/93.1

Printed November 1993

Copies available from:
World Health Organization
Expanded Programme on Immunization
Cold Chain
1211 Geneva 27, Switzerland

Telephone: 022 791 4375
Fax: 022 788 0591

TABLE OF CONTENTS

PART I

SUMMARY OF DISCUSSIONS

1. VACCINES OUT OF THE COLD CHAIN

In the belief that the cooling of vaccines is an important constraint to raising rates of immunization coverage and lowering expenditure on cooling equipment (about 20% EPI costs), the discussion split into two related issues:

- how to speed up the distribution process
- how to relax temperature limits

The shorter the period of distribution, the higher the storage temperatures which can be tolerated without compromising the potency of the less heat stable vaccines.

In some countries, the level of damage to vaccines at peripheral levels within the cold chain may be similar to damage outside the cold chain. In such situations, a fast "warm" distribution and system of use may be just as safe and less expensive than trying to run a standard cold chain to the peripheral level. Perhaps we should concentrate also on a chain where the emphasis is on speed rather than temperature -- a ***fast chain*** rather than a ***cold*** one.

The development of inexpensive indicators for individual vaccine vials is about to make storage "out-of-the-cold-chain" a real alternative. This issue is vital, particularly for polio, neonatal tetanus and measles.

Recommendation: Research into this should perhaps be an operational priority for the EPI.

1.1. Speeding up the distribution process

Rapid distribution of vaccine from centre to periphery demands tight management, precise delivery schedules and reliable transport. For many years China has shown that this is possible. Thailand also has a successful system with set dates for distribution and redistribution at each level, fixed one month apart and allowing just a few days for repacking and despatch. The advantages of such a system are that:

- the average time the vaccine spends in distribution is much shorter than when less frequent deliveries of vaccine are made;
- the capacity of refrigeration equipment can be reduced at intermediate levels;

- the risk to the vaccine due to refrigeration failures is reduced.

However, unless the quantities of vaccine delivered are adjusted according to quantities remaining at the peripheral stores, excess stocks accumulate quickly - a hazardous situation as the security of storage is weakest at that level. The solution is to provide much better information on the rate of use of vaccine from periphery to centre to ensure that deliveries are 'attuned' to consumption rates. The Indonesian method obtains this critically important information by obliging each store to provide its current stock balance with requests for more vaccines.

Recommendations: Review guidelines, manuals and training modules and modify, where necessary, to encourage shorter supply intervals in situations where management of the distribution system and availability of transport allows it.

1.2. Relaxing temperature limits

It is generally agreed that **individual vaccine vial indicators** are an essential pre-requisite to removing any vaccine from the national cold chain system. Whatever changes are made to vaccine handling procedures, it is of paramount importance that the health worker is able to check that it is satisfactory for use before administering it. Vial indicators should start to appear on routine deliveries of oral polio vaccine during 1994 if the terms of the new UNICEF vaccine tender are met.

This decided, the remaining questions which occupied the discussion were as follows:

1.2.1 Which vaccines to take out of the cold chain?

Hepatitis B and Tetanus Toxoid were singled out repeatedly as candidates for removal from the cold chain because not only are they are thermally stable, but there is always the danger that they may freeze in the cold chain. This would carry the potential advantage of increasing immunization coverage in areas not reached by the cold chain.

It may also be possible to take oral polio vaccine beyond the cold chain if the vaccine vial indicator is implemented, together with an 'accelerated' three month distribution period for the vaccine within the cold chain. Whether or not this proves feasible, it may still be possible to take other, more heat stable, vaccines out of the cold chain when the vial indicators are implemented.

Measles may now be kept at +4°C throughout the cold chain -- a policy change which will save freezer space where surplus refrigerator space exists.

1.2.2 What management rules should exist for taking vaccine out of the cold chain?

The vaccine vial indicator is the ultimate signal to reject or accept vaccine for use. If vaccine is taken "beyond the cold chain" at the periphery and the vial indicators warn that the vaccine cannot be used, efforts can be taken immediately to protect the vaccine more effectively in the future.

Management rules which limit either the period allowed out of the cold chain or the maximum exposure temperature may be too conservative or too liberal. Since each vaccine reacts differently according to local conditions, it would be impossibly complicated to implement such rules. Several suggestions along these lines were made and it was agreed that a policy guide to countries is needed. This would outline the circumstances under which it is worthwhile and appropriate either to remove certain vaccines from the cold chain or to take them beyond the cold chain. Until more field experience is gained, it will not be possible to prepare a guide with confidence.

1.2.3 What is the role of field trials of vaccine out of the cold chain?

Field trials, such as those presented on China, show that certain vaccines can be taken out of the cold chain *under certain circumstances*. However, such results are not generally applicable because it is not managerially feasible to monitor routinely for those precise conditions elsewhere.

For this reason again, the time-temperature indicator on each vial is seen to be essential to provide some comparable basis on which to quantify loss of vaccine in field trials. The validity of the indicators should be verified by potency checks on 'rejected' vaccine to confirm the laboratory tests on the calibration of the indicators. Other factors to be assessed include the compliance, acceptability, the training burden and and the impact of the time-temperature indicators on immunization coverage.

Field trials in limited areas should not be allowed to disrupt or confuse health workers in other areas regarding vaccine handling practices. It was also noted that taking vaccine out of refrigeration during the process of distribution is contrary to the manufacturers' recommendations and may violate the licensing laws of the countries of manufacture. These points will need to be resolved when planning field trials.

1.2.4 How can we protect against heat 'spikes':

A number of alternatives to active refrigeration were suggested in order to protect vaccines from extremes of heat exposure, including:

- keeping vials close to the body to limit temperatures to +37°C;
- using cool water from wells or streams;
- evaporative cooling.

Recommendations:

Plan to conduct studies of vaccines out of the cold chain following outline standard protocol which was presented for comment during this conference[1].

Estimate cost impact of removing vaccines from the cold chain and of speeding up vaccine distribution.

Plan to allow measles vaccine to be stored at +4°C at all levels of the cold chain:

- clear this policy change within WHO;
- write to all vaccine manufacturers for their reactions;
- announce the change in the next *Technet News;*
- review all training materials for what changes are needed

Conduct studies to check the protection against heat provided by a variety of methods, possibly using the Tiny TTM recording device[2].

1 See *Technet Conference Document*, page 76.
2 See *Technet News* (Newsletter), March 1993.

2. VACCINE SUPPLY ISSUES

Vaccine supply issues are causing Technet activities to be reappraised in light of recent developments. It is time to examine all practices which link questions of the cold chain, vial opening rules and financing. To meet the challenges of the 90s and to convince countries to accept their share of responsibility, the EPI must be seen as an efficient programme.

One of the most significant recent developments in cold chain technologies is the vaccine vial indicator, a device which indicates cumulative heat exposure. Its imminent introduction into the programme complicates discussions on vaccine forecasting as it will almost certainly affect vaccine handling policies and associated wastage.

The possibility provided by this indicator to relax the very conservative cold chain requirements and even take vaccine "beyond the cold chain" (discussed above) is related to some extent to its use in handling opened vials. In removing the risk of heat exposure, it allows us to review the rule of throwing away opened vials at the end of each day. A vaccination programme which combines the judicious use of vaccines outside the cold chain with more liberal rules on use after opening could be expected to have higher coverage and lower wastage. There is no doubt that more operational research on both topics is essential and studies such as those described in the preceding section should be carried out widely.

2.1. Vaccine wastage

One of the major causes of high vaccine wastage is the recommended practice, standard in most countries, of throwing away all unused vaccines in open vials at the end of a session.

A dose of vaccine is considered "wasted" if it has been thrown away without being of *any benefit* (direct or indirect) to the programme. By direct benefit signifies the provision of protection to a child and/or woman -- whether this protection is effective or not. Vaccine given to a child who subsequently dies cannot be said to have been wasted; no children would be immunized at all if vaccine was withheld because a child might die. Indirect benefit is the indication that the programme is following its operational guidelines which ensure the best opportunities for immunization.

2.1.1 How much vaccine is wasted?

Most of the vaccine supplied by UNICEF is in excess of the amount required for the recommended EPI schedule. A simplistic calculation shows that if UNICEF is spending US$ 60-70 million annually on vaccine, US$ 30-35 million of that is wasted -- with perhaps US $20 million worth of TT and DPT vaccines accounting for more than half the wastage. This hypothesis of high wastage figures takes into account the sum of the surviving infants in countries that UNICEF supplies, together with the coverage and the number of doses recommended in the EPI schedule. From this it emerges that more than twice the number of needed doses are supplied. In 1990 the total "wasted" doses accounted for 58% of the total doses shipped. However, if UNICEF's expenditure on extra doses effectively gives health services the best possibility of fully immunizing children, the excess expenditure may be seen to offset the costs that would have been required to cure those children if they had not been immunized.

2.1.2 Can we reduce wastage?

Wastage can be reduced if the recommendation to destroy open vials at the end of a session is changed. Such a course is, however, fraught with operational problems and the discussion focused briefly on the reasons underlying the original recommendation, namely:

- to avoid all risk of heat exposure;
- to avoid vaccines in multi-dose vials from becoming contaminated.
- to provide a simple managerial guide as to whether vaccine had been taken out of the refrigerator and thereby exposed to conditions which may have spoilt it; and
- to simplify training.
- to ensure that vaccines are stored conservatively (with regard to heat exposure).

Wastage is a reality, though not necessarily a bad one, and it calls for an active, rather than a passive, approach. It was proposed to ask national programmes three questions related to vaccine wastage:

(i) Is there one optimal presentation or would more than one presentation be preferable?
(ii) Is minimum wastage bought at the cost of other aspects of the health service?
(iii) Could operational aspects be changed economically to help reduce wastage?

Vaccination strategies should consider wastage as one of the basic aspects to consider in planning -- for instance, the choice of vial size has a major effect

on wastage, particular sizes being most appropriate for sessions of certain frequencies.

Using vaccines on several days will no doubt save large amounts of money in terms of reducing wastage. In fact, there is *already* a widespread practice of keeping vials for more than one day despite the current guidelines to throw vaccine vials out at the end of each session.

The cold chain in industrialised countries is probably not significantly better than the cold chain in developing countries. However, throughout the industrialised world, multi-dose vaccines are not thrown away at the end of the day but kept until the vaccine is finished.

PAHO have observed this practice in the Americas for a number of years and found the fears of problems to be largely unfounded -- on the contrary, PAHO considers that keeping some vials open for more than a single session is acceptable and provides excellent efficiency in vaccine utilisation. Accepting it as an existing practice (not one which they introduced), PAHO concluded that guidelines to help make it safer would be more appropriate than no guidelines at all. They therefore published in a recent *PAHO Newsletter* a set of basic rules to observe in keeping vials open over several days.

The fact that the PAHO system may have encouraged, or at least *not discouraged*, this practice is seen by some countries to raise the possibility of misunderstandings by staff and also a tendency to "extend" existing guidelines. Whether we agree or not with the introduction of a policy for using open vials on subsequent days, safety must be considered on two major issues:

- heat exposure and
- contamination.

The problem of ***excess heat exposure*** should be removed by the introduction of individual vaccine vial indicators. That leaves ***contamination of the vaccine within the opened vial*** as the only reason to throw out vials and thus waste vaccine.

2.1.3. Contamination of opened vials

Work in the United Kingdom has produced some very positive preliminary results on the use of DPT vials kept open for periods of up to three months. Results so far show that:

- The preservative in bacterial vaccines slowly overcomes any contamination inadvertently introduced into the vial. This means that the

vaccine is safer to use the day following contamination than on the same day it occurs, i.e. the second day is safer than the first day.

- Bacterial vaccines kept at room temperature become safer more quickly. This indicates that a practice of keeping the vial at moderate temperatures and using the vaccine on subsequent days will minimise any contamination risk. This is contrary to the EPI recommendation to use TT and DPT in one day only, a recommendation ***which may maximise the contamination risk.***

Keeping vaccine vials open, however, is dangerous when it comes to freeze dried vaccine and this is the basis for the most convincing argument against keeping vials for more than one day. There have been many deaths from contaminated measles vaccine kept at room temperature for several days after reconstitution. Freeze dried vaccines do not have preservatives so it is dangerous to keep them for more than a few hours. Any contamination will grow as if it is in a medium, particularly if the vaccine is not kept cold. Members pointed out the dangers that could result if guidelines, such as those issued by PAHO, were misunderstood and freeze dried vaccines (measles or BCG) were kept for more than a single session. The surveys in the Americas have so far not encountered this problem.

In some countries where TT and DPT were kept open and used for periods of up to one month, many health workers reported seeing abscesses. This could be a sign either of contamination or poor injection practices.

Another contamination risk is from the needles. However, it was observed that, if a programme allows the use of contaminated needles, it is inappropriate for that programme to be immunizing children anyway.

Policy on open vials: If the global policy on disposal of opened vials is to be changed, then the worst possibilities and situations must be considered. It will be necessary to introduce new guidelines or rules which will be followed and not abused. In theory it *should* be possible to train staff to handle vaccine properly and to keep only one vial open at a time. However, although the current guidelines in most places are to dispose of all opened vials at the end of the day, it is common to find opened vials in refrigerators in nearly every country. So, if condemning the practice does not prevent it, how much worse will it be when rules *allow* it? How can we ensure that guidelines to ensure the safety of using opened vials for a specific period will be followed? Would countries follow guidelines which allow certain vaccines to be kept out of the cold chain for various periods at various temperatures? What would happen if *each* level of the cold chain considered it reasonable to leave vaccine out for the allowed period of time?

Another risk of allowing opened vials to be kept is that it makes it easier for staff to practice bad stock control. In some health centres as many as 17

opened vials of DPT have been found in a refrigerator at the same time. This also means that more vaccine is locked up in the country's overall vaccine pipeline than is necessary.

The costs for retraining would be more than offset by the savings from the reduction of vaccine wastage (they would hardly exceed 2% of the estimated savings). Rules could be established by retrain health workers to minimise problems, such as the need to:

- Finish one vial before another is started.
- Never, never open a second DPT/TT etc. until the first one is either finished or destroyed.

Recommendation: Conduct contamination tests on vials which have been kept open at the end of one months use. Such data from the real world would help speed a decision to keep vaccine vials open for more than one day.

2.1.4. Single/multi dose vials

If, despite the UK findings, contamination proves to be an issue, consideration must be given to moving away from multi-dose vials to single dose vials -- an expensive proposition.

Fears that a range of vial sizes may cause problems in the health services were contradicted by experience in one country where the manufacturer issues both single and multi dose presentations of the same vaccine. Its measles vaccine, for example, comes in any number of doses between 1 and 10. The fact that no difficulties with this have been observed shows that it *is* possible to have more than one presentation for a vaccine. A low workload rural health facility will not necessarily use the same vial size as a high work load urban one.

The use of multi-dose vials for pharmaceuticals, including vaccines, is widespread in the USA. Vials are kept for extended periods of time with documented safety. There are numerous published studies on contamination available, but nearly all are from hospitals in industrialized countries.

2.2. Move towards self financing

UNICEF has done a tremendous service in showing that all of the worlds children can be vaccinated if there is a will. However we should not expect that vaccines will be provided free of charge forever. Immunization is the most cost effective health strategy that we have and the time has come when countries have to take on more financial responsibility for the EPI. Some

countries are already in a position to do this; others, which are not yet ready, will require longer term donor support.

Immunization is such an important part of a health programme that there is not a single country that **cannot** afford to assimilate the cost of its own vaccination programme **at some time** in the future. The Vaccine Independence Initiative (VII) helps countries both in the long term and in the transitional period as they move towards autonomy in vaccine supply.

As the 1980s were remarkable in their achievements for the EPI, so the major challenge for the 1990s is to make the EPI sustainable. Many of the practices that were originally introduced were necessary to make the programme work; the next step is to achieve substantial levels of coverage.

During the 1990s countries will take over responsibility for vaccine provision and will not accept or afford practices that are wasteful. Countries that pay for their own vaccine, as in South America, will inevitably adopt systems that are efficient in the use of vaccine. As more and more countries move towards self-financing their vaccine supplies, it is the right time to introduce vaccine handling guidelines which ensure that efficiency will not compromise safety and/or effectiveness.

2.2.1. Strategies for vaccine procurement

In 1991 50 nations, mostly from the developing world, called on the establishment of a Global Fund for Hepatitis B (HB) Vaccine Procurement, such as Rotary International has done for polio. This provides another alternative for financing the purchase of new EPI vaccines.

It would seem that using international competitive bidding procedures may be a worthwhile option both for middle income countries with medium or large populations, as well as for low income countries with medium or large populations and access to hard currency (through the World Bank or other development funding). The benefits to these countries that could come from carrying out international competitive procurement for vaccines are the following:

- Institution building: Technical assistance and experience gained in carrying out an international procurement will result in knowledge of internationally accepted tender and bid procedures, contracts and contracting procedures, banking procedures and payment modalities. These skills will help countries do business in the world market place and are especially valuable for countries now striving for transition to a free market economy.

- Cost savings: Countries that have access to foreign currency, a relatively low cost for carrying out their own procurement activities, and which have a high enough demand, may be able to lower the net total cost of their vaccine purchases through large scale procurement directly from vaccine manufacturers.

2.2.2. Children's Vaccine Initiative (CVI)

Work within the Children's Vaccine Initiative (CVI), at least within the Task Force on Situation Analysis is moving towards evaluating vaccine needs in a seamless fashion -- that is, while we focus on highly visible problems, such as shortage of EPI vaccines, all the working strategies assume that there will be large number of new vaccines which have not yet been adopted by the countries. HB could be considered the last of the current EPI vaccines or the first of the CVI vaccines. Countries wanting vaccines in the future may find it hard to identify donors.

Such a strategy is necessary if we are to get widespread introduction of the exciting new vaccines and vaccine combinations just around the corner. By letting UNICEF be the major bidder, orders are concentrated and allow the buyer to have a large influence on the prices. UNICEF vaccine prices dropped when long term bids were issued and the prices were stable for many years. Even the most recent price increases did not bring the vaccine prices to match inflation for the past 10 years.

The key to expanding the EPI from where we are now, to where we want to be with disease reduction targets and adoption of new vaccines, is country responsibility for vaccine supply as well as the country programme. The Americas have clearly shown what is possible by insisting that countries take responsibility all the way through. If a country needs help to become self-sufficient, they should be helped. Free vaccines should only be an interim step towards complete country responsibility for the programme.

If the country can buy directly then the UNICEF price can be used as its point of reference in negotiations. In the area of essential drugs some countries ask UNICEF to participate as a bidder. If UNICEF receives the lowest bid, the countries buy through UNICEF. If not, they buy directly. There is no reason why this procedure cannot also be used for vaccines.

Some countries may be slow to adopt the use of HB because they are still expecting it to be provided free of charge. However, if it is known that there will be no such gift they might address the problem on an individual country basis and rapidly introduce HB.

One of the most promising areas for further cost reductions is that of multi-valent vaccine formulations where new vaccines such as HB or HiB are

combined with another EPI vaccine, such as DTP. Reducing the number of EPI injections reduces the cold chain storage capacity requirements in needles, syringes, fuel, and sterilization equipment, vaccinator time, and expansion of record-keeping activities, not to mention the cost of vialing, labelling, packaging, and shipping separate doses of vaccine.

It is important to work with manufacturers to stimulate the supply of sufficient quantities of new vaccines at prices that will enable developing countries to undertake programmes of mass vaccination. A detailed cost analysis conducted in 1990 indicated that, at a production level of 4 million doses per year, the marginal cost of HB vaccine production is about US$ 0.40 per dose. At production levels of over 8 million doses per year, the marginal cost of production drops to US$ 0.20 per dose. Vaccine costs could therefore be reduced significantly if large-scale immunization programmes were undertaken.

2.3. Other areas for cost reduction

Cost reduction should be addressed by promoting more efficient cold chain, delivery and supply management systems. Unfortunately, these were not priorities in the '80s when most EPI programmes were launched -- usually with an abundance of financial assistance. We are now working toward reducing vaccine wastage through selection of appropriate vial sizes, vaccine handling practices and better forecasting, but what about the cold chain? At an EPI AFRO meeting last year, it was observed that cold chain storage capacity in Africa is well beyond requirements. Perhaps we need to be more critical on the quantity and type of cold chain equipment we are purchasing or replacing.

Cost reductions are important and indeed we do focus on the economics of vaccine but it is more important that the vaccine is affordable rather than cheap. Vaccines are sold in the USA at quite high prices which are, however, affordable. This allows for vaccines for developing countries to be purchased at a different price level which is proportionately affordable relative to a different market.

2.3.1. New vaccines

The issue of newer vaccines that are now available - Hepatitis B (HB) and Hemophilis influenza B (HiB) -- or vaccines which will hopefully be available in the future, such as a vaccine against HIV, were not discussed during the Technet Conference. However, the 1992 World Health Assembly recommended that HB vaccine should be included in all national EPI programmes by 1997. Although paediatric doses of HB vaccine can now be purchased for as little as US$ 0.55 per dose, this is still high relative to other

EPI vaccines -- three doses at US$ 1.65 more than doubles the cost of the current cost of a complete series of EPI injections.

It would seem that the Children's Vaccine Initiative (CVI) strategy of looking at cost reduction through alternative means of vaccine production, formulation, and delivery mechanisms will play an important part in ensuring adequate and affordable future vaccine supplies. Groups such as the International Task Force on Hepatitis B Immunization are also focusing their efforts on mechanisms to further reduce the cost of new vaccines.

2.3.2. Combination vaccines

Combination vaccines may, *repeat may*, be cheaper but will also shift the burden of payment. At present most of the world's vaccine is produced and paid for by the country using it, while most of the imported vaccine is paid for by UNICEF. If combination vaccines have to be imported there will be a tendency to expect UNICEF to pay but this cannot be counted on. If we substitute local production for high tech production in an industrial country we may not end up with a cheaper product. The savings from introducing a combination vaccine will be in the area of administration of the vaccine.

2.3.3. One injection versus two

The jet guns being proposed by PATH and others reduce the individual cost of an injection so the cost saving of combination vaccines would be lost. There is also some possibility of having jet guns that mix the vaccine at the time of injection. For instance, locally produced DPT could be blended during the injection with imported HB. This might be the most economic way to provide the vaccine. As is evident from other papers, it may be possible to keep HB out of the cold chain. However, if it is blended with DPT it will have to be stored according to the conditions that apply for DPT. HB will be very expensive in EPI terms and we could not afford the more than 50% wastage associated with DPT. We would have to move towards smaller vials with a larger per dose volume. Combining HB with DPT may thus increase the volume within the cold chain as opposed to keeping them apart which would not.

3. INJECTION PRACTICES

It has become evident over the past years that dangerous injection practices are widespread. Unless something is done about the situation, it will no doubt backfire on the EPI at some point. Lack of injection safety was a dynamic topic at the last Technet meeting. Members had hoped that a number of injection practice surveys would be conducted before this Conference and would provide a base-line for comparison of practices before and after the introduction of auto-destruct syringes. However, only three or four surveys were completed. Participants agreed nevertheless that we should proceed with plans to conduct a post-market evaluation of auto-destruct syringes.

The situation concerning injection safety is still not acceptable. EPI reviews and trip reports describe a rather terrifying injection safety situation existing, to some extent, in most of the developing countries --despite more than 10 years of training, supervision and reviews.

The papers presented for discussion were:

- The new draft of the EPI policy document on safe injection practices. This was split into several sections and posted under relevant headings to allow for discussion on various aspects.

- A paper on *Injection Practices in Papua New Guinea*[3] which described practices in that country.

3.1 Why do unsafe injection practices occur?

In many instances, **no proper training** has been provided when sterilization equipment is introduced into the programme. This is a serious mistake as, besides the implications for safety, it can also lead to the wrong motives for choosing disposable syringes.

In programmes where **training has been provided**, it has often been given **to the wrong people**. A survey in the Côte d'Ivoire[4] showed that health workers who received training were **not** those who were giving injections, sterilizing equipment or going for outreach sessions! It is common practice in some countries for the trained health worker, who has a certain status, to "recruit" a

---

3 See *Technet Conference Document*, page 79.

4 *Evaluation de la Chaîne du Froid, République de Côte d'Ivoire*, OMS/UNICEF/USAID, novembre 1992.

local help. The local help does those tasks and is seldom supervised. His "training" is generally limited to the instructions he is given or what he picks up from watching the health worker. When a supervisor visits the health centre his discussions are generally with the health worker, not with the help!

3.2 What can we do

We have to plan a formal, systematic approach whereby we:

- focus our attention primarily on the many programmes where unsafe practices have been reported, and
- on the basis of these reports, together with an appraisal of the disease risk and/or burden, target high risk areas;
- decide on a strategy which takes account of one or more of the following schemes:

  Informing the public about sterile practices;
  Offering the public the chance to buy disposable syringes;
  Introducing auto-destruct syringes;
  Training health workers in sterilization practices.

3.2.1. Inform public about sterile practices

Perhaps the best way to achieve injection safety is through the clients. We can be sure that:

- If communities choose to buy their own syringes they evidently require the security that disposable syringes offer.
- If they accept sterilizable syringes from the health centre then this standard is acceptable to them (unless they can't afford to buy).

Communities should be informed about the acceptability and/or unacceptability of certain practices, and encouraged to demand and accept nothing but safe practices, not only from EPI but from all of the providers of injections. In Papua New Guinea EPI injections constitute less than 1% of the total number of injections given annually. If we take up the issue of social mobilization for safe injections we could upgrade the standard of all the practices within the country. However, we must be sure that:

- our message does not alarm clients to such an extent that they avoid injections;

- safe equipment *is* available to meet their expectations, no matter what type.

Uganda has a very open and aggressive approach on the AIDS epidemic. They promote education and communication on HIV transmission and AIDS, and have thoroughly implemented the use of reusable needles, syringes and steam sterilizers. EPI/Uganda consistently finds that better informed mothers are:

- aware that HIV can be transmitted by unsterile injections,
- not fearful of EPI injections, and
- more likely to have fully immunized children.

Furthermore, Uganda's immunization coverage continues to increase. In preventing loss of confidence in immunizations (injections), this approach is more cost effective and sustainable than providing disposable equipment, whether free or for a fee.

3.2.2. Sell disposable syringes

As the conference progressed, the possibility of selling syringes and needles was frequently discussed. Some members supported the proposal while others warned of its potential problems. There was, however, a tendency towards an overall acknowledgement that there *are* benefits to this scheme in some situations.

Health care personnel report that mothers are generally willing to purchase a needle and/or syringe because of their concern about HIV transmission. Furthermore, many mothers prefer disposables as they give less painful injections than sterilizable syringes.

Selling vaccination equipment is already practised in many countries. In some instances people are requested to bring their own needle and syringe which they buy from the local pharmacy. More often, however, the health worker sells needles and syringes, either separately or as a single unit to each client while he/she waits in the queue for vaccination.

In Nigeria a lot of publicity has focussed on the relationship between injections and HIV and mothers have to purchase syringes for use in the vaccination activities in several areas. If they cannot buy equipment that they know is safe, it will be very detrimental to the EPI.

By selling syringes we make clients responsible for injection safety. This may be a possible solution which will increase the safety of injections to the level demanded by the community, without making the EPI go broke. It shifts the burden of payment for needles and syringes from the donor or the

government to the user. Is this bad? If the clients are prepared to pay and can afford to pay, is this not a truly sustainable system?

Some participants considered that fees for service are a good idea, particularly for something like immunization cards. Considering that many EPI clients fall within the US$ 100 per year range, the family's cost for disposable equipment for preventive and curative injections will be quite significant. Disposables may be preferable for preventing disease transmission, and are more "user-friendly". There is a question of how many countries are capable of purchasing and distributing syringes continuously, even if the client pays.

Advantages

- **Cost benefit:** Syringes are, theoretically, being sold at cost without a profit and the revenue from sales is welcome. The price charged by a pharmacy for needles and syringes includes a nice profit for the pharmacist. It was observed in one country that the selling price of syringes in pharmacies was significantly higher than the imported cost. This profit should motivate the pharmacy to have the syringes always available. People are used to paying for prescriptions and so the purchase of syringes is not considered unusual. However, if EPI sells the syringes, the revenue benefits the programme. The management system established for selling cards could be applied also to the sale of syringes, with the joint revenue from the syringes and cards being used for the same purpose.

  Selling cards not only raises money which can be used to purchase vaccines which are not covered by other sources of payment, but also increases card retention. In Burkina Faso where the cards are sold, many centres also require the clients to purchase their own syringes and needles.

  In the Cote d'Ivoire the sale of injection equipment provides a substantial income to the health centre. This is used to purchase gas and pay expenses such as transport to fetch the vaccines. However, there is a problem because these sales are not official policy; they are a staff initiative, conducted without the approval or knowledge of the regional and/or district medical doctor.

- **Preference for disposables:** Many mothers prefer disposables as they give a less painful injection than the sterilizable syringes. It is possible that another reason for the preference for disposables lies with the health workers who find them more convenient.

- **Community has confidence:** Giving a community the option to purchase sterile disposable equipment gives those who are concerned about disease transmission the assurance that the vaccination will not cause a new disease and allows them to retain their confidence in the safety of the immunization programme.

Disadvantages

- Although most ministries of health would jump at the chance to implement a system whereby the mothers pay for syringes, there are many millions of families that cannot afford to purchase syringes. If this policy iss actively encouraged by WHO/UNICEF it could have serious consequences on the immunization coverage.

- A policy which requires clients to purchase and bring their syringes assumes that this equipment is available on the local market. This may be possible around urban centres but is likely to be more difficult in rural areas.

- Purchase of disposable equipment does not always lead to a safe injection. Some programmes purchase only needles and use a common syringe for everybody.

Points to consider if this policy is implemented

- A policy covering the sale of injection equipment will have to be drawn up, even if this practice is only established at district or regional level. It should establish guidelines to prevent abuses and avoid discrepancies between health centres.

- Sterilizable equipment should still be available at no charge:
  - for people who have confidence in the health centre,
  - for people who cannot afford to purchase their own needles and syringes, and
  - for people who live in rural areas where they have no possibility of purchasing disposable equipment.

- In areas that are experimenting with the Bamako Initiative the sale of needles and syringes for EPI could be studied as a viable option for cost reduction in EPI activities.

3.2.3. Introduce auto-destruct syringes

The cost of auto-destruct syringes is a serious disadvantage and participants recommended that:

- Auto-destructs should only be used where practices are known to be unacceptable.

- Auto-destructs should not be introduced to replace disposables simply for the sake of convenience or to make injections more comfortable in programmes where current practices are already safe.. In such cases their high price is not justifiable unless the patient is willing to cover the cost. If auto-destructs are included among the syringes available for sale, patients would be 100% sure that they are getting a sterile syringe and the high cost burden would not be on the EPI.

3.2.4. Train health workers in sterilization practices

All the injection practice studies which have been completed to date indicate that appropriate and adequate training is vital if practices are to improve. We have to make an enormous effort to:

- train health workers, especially with respect to the introduction of steam sterilizers;
- extend an awareness of injection safety issues to communities.

In most countries, training will be an expensive undertaking, especially where per diem and travel costs are high. However, the overall cost of changing over to a system of reusable syringes, plus the provision of training, may amount to less than the cost of treating HIV and other infections caused by incorrect injection practices.

A study of injection practices may well show the advantages of using sterilizable syringes and needles. Sterilizable equipment is far more sustainable in situations where the EPI must cover its costs. But are we swimming against the tide? Some mothers are demanding new disposable equipment and their concerns cannot be ignored. We cannot impose any particular type of equipment on programmes but we should insist that health workers use the equipment in a safe manner. Sterilization is important for many PHC programmes so correct sterilization techniques are important for many reasons.

The new injection policy text recommends that all health centres should have sterilizable syringes and sterilizers. This equipment:

- provides a back-up in case there is a shortage of disposable syringes;
- can be used for clients who have no money in situations where the practice is for patients to buy their syringes.

It was reported from Burkina Faso, Papua New Guinea and the Philippines that the clients choose to purchase their own equipment, although sterilizable

syringes are available. In fact, sterilizers often remain unused in the Philippines and Burkina Faso where communities demand disposable syringes. It was also noticed that quite often, at least in some areas, disposables are used not because they are requested by the clients but because the health workers impose their use.

3.2.5. Clamp down on key bad practices

It was unanimously agreed that behaviours, such as reuse of syringes from client to client, or only changing the needle, are unacceptable within the EPI and we *must* find ways to end them.

4. REDUCTION OF CFCS

4.1 Background

CFCs (chlorofluorocarbons) and HCFCs (hydrochlorofluorocarbons) were once considered ideal refrigerants. They are non-toxic, non-flammable, very stable and possess a range of pressure-temperature relationships which are suitable for a wide variety of applications. However, recent concerns about the effects of CFCs and HCFCs on the environment (see tables below and Working Paper[5]) have changed this view to such an extent that the entire group is to be phased out and banned from use in the very near future.

International regulations have been drawn up with stipulations for the following deadlines:

The Denmark Regulations ban R11 from 1 January 1994
The EEC Regulations ban R12 from 1 January 1995
The Montreal Protocol bans all CFCs from 1 January 1996

Table 1: Properties of principal fluorocarbons

Refrigerant No/Type	Boiling point °C	Ozone depleting potential	Global warming potential
CFC11	+24	0	.0
CFC 12	-30	.0	3.1
CFC 113	+48	0.85	.3
CFC 114	+4	0.7	4.2
CFC 115	-39	0.4	9.8
HCFC 22	-41	0.05	0.37
HCFC 123	+27	0.02	0.02
HCFC 124	-12	0.02	0.1
HCFC 141b	+32	0.09	0.09
HCFC 142b	-9	0.06	0.37
HFC 32	-52	0	0.13
HFC 125	-49	0	0.61
HFC 134a	-27	0	0.29
HFC 143a	-48	0	0.77
HFC 152a	-25	0	0.03

5 See *Technet Conference Document*, page 87 (CFCs and the new generation of refrigeration equipment).

Table 2: Worldwide consumption of CFCs - 1988 (K Tonnes)

	CFC11	CFC12	CFC113	CFC114	CFC115	Totals
Refrigeration	35	295	1	2	6	349
Aerosols	85	00	3	8	-	96
Foam-closed	80	60	4	2	-	246
Foam-open	90	0	1	2	-	03
Solvents & other	20	20	236	2	-	279
	410	485	245	6	6	172

4.2 A new generation of equipment?

Most of the HFC compounds listed in Table 1 are now under development and some are already available. A replacement for R12 (CFC 12) is by far the most urgently needed. Not only does R12 account for 85% of all refrigeration use but, as shown in Table 1, it is also one of the most harmful CFCs.

From the Technet perspective, virtually every item of cold chain equipment used for the transport or storage of vaccines uses R12 in some form -- either as a refrigerant or a foaming agent for insulation, or both. The compound chosen to replace R12 is HFC 134a, although in some quarters propane (HFC 290) is strongly supported. HFC 134a performs like R12 and can be used as a direct replacement gas in a compression refrigerator or freezer, provided the original compressor oil is changed.

Danfoss compressors specifically designed to use HFC 134a are currently in production and some manufacturers are already producing domestic refrigerators fitted with the new compressors. Vestfrost, or instance, have announced that all their refrigerator and freezer products will use CFC-free insulation as from June 1993, and their changeover to HFC 134a compressors will be achieved by mid-1994.

Existing equipment which has CFC and HCFC compounds already in the cooling system may continue to be used. Careful servicing of such equipment can make a major contribution to reducing further emissions. It is essential to recover and reclaim used gases and a number of schemes are already available in Europe and USA to ensure re-cycling of refrigerants.

4.3 The future

There will soon be no supplies of CFCs or HCFCs available, even to service existing equipment. New compounds and new equipment are becoming increasingly available and the means for an orderly changeover are being provided.

4.4 Activities and plan of actions for Technet

The time has come to move away from environmentally harmful CFCs and HCFCs. The most favourable timetable for implementation of the inevitable transition is the one that begins ***today***. Although cold chain equipment represents a small fraction of the refrigeration market, most Technet members agree that, rather than passively waiting for industry to implement changes, the network should play an active role in this field.

The priority activities listed below will be undertaken by WHO/EPI and/or Technet members.

4.4.1. Global

- Recommend to UNICEF that after the end of 1995 they stop purchasing equipment which doesn't conform to the CFC/HCFC bans.
- Urge countries to start purchasing CFC-free equipment as soon as possible.
- Consider ways to assist manufacturers in developing countries in changing to CFC-free production. This is particularly important for cold box and vaccine carrier manufacturers whose products are listed in the *Product Information Sheets*.

4.4.2. Standard Performance specifications

- Revise *Equipment Standard Performance Specifications* to include information on present gas used by each product and then 1 January 1996 deadline for changover to HFC equipment.

4.4.3. Product Information Sheets

- Indicate which refrigerants & foaming agents are currently used in all refrigerators, freezers, cold boxes and vaccine carriers.
- Conduct performance tests on selected refrigerators using new foam and new refrigeration circuits. On the basis of results, assess the need to retest all appliances.
- Conduct tests on the longevity of R12 compressors, cleaned and operated with R134, and/or R12 compressors.

4.4.4. Relations with industry

- Work with manufacturers to facilitate the conversion.
- Take account of the imminent change to CFC-free products when planning the purchase of new cold chain equipment and/or the

replacement/upgrading of existing equipment; make suitable provision for training, spare parts, gas supplies, etc.

- Ask individual manufacturers to provide suggestions on how their product/s will be serviced and/or repaired as R12 becomes more scarce, and what modifications, spare parts, etc. will be needed to adapt them to use non-CFC gases.
- Request manufacturers to provide cylinders of R134A to countries where equipment with R134A is in use but not manufactured or available locally.
- Make sure that new R134A compressors are clearly marked to avoid confusion during servicing.

4.4.5. Reclaiming and recycling

Members agreed that, although collecting and recycling CFCs from cold chain equipment is an important activity, it will be very difficult to put into practice in most countries. Despite this consensus, areas of possible action were identified:

- To develop a new training programme and appropriate materials, as part of the present *Repair Technicians and Users Maintenance series,* to cover recycling of CFCs plus refilling and modifying existing cold chain equipment.

- To include equipment for reclaiming and/or recycling of CFC gases in Section E7 of the *Product Information Sheets.*

- To consider making a recommendation that reclaiming and recycling be limited to those areas where it is safe and feasible and where storage and transport are not a problem.

4.5. References

Working Paper: CFCs and the new generation of refrigeration equipment?, Gordon A.Larsen

5. DOMESTIC REFRIGERATOR UPGRADE KITS

5.1. Background

A number of countries have purchased -- and will continue to purchase locally -- manufactured domestic refrigerators for storing EPI vaccines. This is the case, for instance, in China, Ivory Coast, Malaysia, Pakistan, Philippines and Thailand.

There are a number of advantages to using domestic refrigerators besides the fact that they are locally available. Spare parts are also readily available so repair and maintenance is usually easier than for imported equipment. No foreign currency is required for their procurement so they can be purchased even at sub-national level with local funds.

There are, however, some disadvantages concerning the maintenance of recommended temperatures for vaccine storage, particularly in the case of power failures. WHO/EPI has therefore supported laboratory tests on domestic refrigerators in Colombia and Australia with the aim of developing a simple modification kit that can be installed in the field on a variety of different domestic refrigerators.

5.2. Developments

The laboratory tests have basically focused on two aspects: (1) to increase the thermal mass by using water-filled containers and (2) to add insulation either from the outside or from within (inside the door and/or by using insulated containers). The results are encouraging and demonstrate a significant improvement in the temperature distribution and holdover time (see table below).

However, under field conditions it may not be easy or practical to apply some of the suggested modifications, such as adding insulation in the door or on the outside surfaces of the refrigerator or manufacturing wire baskets to hold icepacks. Modifications such as increasing the thermal mass and using simple insulated containers inside the refrigerator should be more practical.

In some cases, rather than trying to upgrade the appliance in the field, it might prove easier and safer to modify a batch of newly purchased domestic refrigerators in a workshop before they are delivered.

Table 3: Results of comparative tests on normal and modified domestic refrigerators at 32° and 43°C

Code	Ambient Temp. °C	System	Temperature °C		Holdover time (hours)
			Maximum	Minimum	
E3-2064	32	Normal	6.2	1.3	2.6
	32	Modified	5.8	1.1	13.0
	43	Normal	6.2	2.1	1.6
	43	Modified	7.0	0.8	4.8
E3-2069	32	Normal	4.1	-0.2	2.1
	32	Modified	4.0	1.0	7.0
	43	Normal	7.6	2.4	1.1
	43	Modified	5.5	1.3	4.7
E3-2073	32	Normal	5.3	2.1	2.5
	32	Modified	4.5	1.3	6.0
	43	Normal	6.7	2.0	0.8
	43	Modified	6.9	2.5	3.2
E3-2074	32	Normal	7.4	3.4	1.3
	32	Modified	3.5	0.3	6.0
	43	Normal	4.4	-0.7	2.2
	43	Modified	5.8	0.7	4.4
E3-2076	32	Modified	5.0	3.1	12
	43	Normal	8.1	2.4	1.1
	43	Modified	7.5	1.3	7.0
E3-2078	32	Modified	6.0	1.5	10.0
	43	Normal	7.5	2.5	1.3
	43	Modified	6.0	1.0	3.0
E3-2079	32	Normal	6.0	3.5	2.0
	32	Modified	3.4	0.3	9.0
	43	Normal	7.8	3.0	1.5
	43	Modified	5.7	0.2	7.0

Last, but not least, some domestic refrigerators should not be upgraded. It is important to make a decision not only on the basis of age but on a number of other factors. The Pakistan EPI, for example, has domestic refrigerators in use which, though only two or three years old, are in very poor condition; they break down more frequently than similar but much older models. Another factor to bear in mind is cost. To use the Pakistan example again, the initial cost of the refrigerators was approximately US$ 150 while the cost of *replacing* the compressor from the local market is more than $120.

5.3. Future activities and plan of actions for Technet

Existing guidelines and options will be included in a manual for wide distribution. The key factor is to "Keep things cheap and simple". Guidelines will cover the issues outlined below:

- Identify countries which use a large number of domestic refrigerators as a focus then:
  - Assess whether their vaccines are at risk. How well are the refrigerators insulated? Is the power supply reliable? Are there wide temperature fluctuations, etc.?
  - Discuss findings with national level authorities and inform them of existing techniques to help upgrade refrigerator performance.
  - Offer to monitor the performance of their domestic refrigerators during the warmest period of the year. Technet has initiated such studies in Colombia and Thailand and more are scheduled for Iran, Pakistan and Malaysia where the performance of existing unmodified domestic refrigerators will be monitored in parallel with modified versions of the same model.

- Once the amplitude of the problem has been assessed decide on the following, with the ministry of health:
  - do their domestic refrigerators need to be upgraded; and
  - will simple upgrading in the field (such as the addition of water mass or better management of the refrigerator) be sufficient or should more complicated modifications be introduced?

- If more complicated modifications are required:
  - Can a standard kit be manufactured locally that can easily be fitted to existing models already in use in the field?
  - Can the appliances be modified in a central workshop before they are delivered to the field?

5.4. References

Working paper: Domestic refrigerator upgrade kits, by Mauno Erkkilä, Alan Schnur, Chris Maher
Other documents: MUERI and UNIVALLE tests reports; UNIVALLE draft manual; EPI Field trial protocol (draft 3)
On-going activities: UNIVALLE development of a standard kit
Field monitoring of domestic refrigerators in Colombia & Thailand

6. EQUIPMENT FAILURES

Papers[6] presented on this subject described problems with various appliances and the solutions that had been proposed and, in most cases, accepted by the countries. These issues did not provoke any discussion or lead to any questions.

6 See *Technet Conference Documents*: Indonesia - Explosion of FCW20 kerosene freezer, page 97; Electrolux RCW42EK rehabilitated, page 101; Failure of icelining refrigerators/freezers, page 104; Current status of Vestfrost icelining refrigerators and freezers, page 107; and Problems with electric elements for Sibir, page 109.

7. THERMOPACK SYSTEM

7.1. Background:

The Thermopack System is a stainless steel transport container sealed to contain a certain amount of ice. High quality vacuum insulation enables it to maintain temperatures between 0°C and 8°C for a theoretical limit of up to 180 days (in practice, 90 days).

The container is disposable and, once opened, the contents have to be used immediately. The storage temperature can be varied from -20 and +4°C, depending on the choice of cooling substance; ice, for example, gives a temperature close to 0°C. The contents may comprise a combination of vaccines with similar storage requirements.

The container is 305 mm in height with an outer diameter of 240 mm. The total weight, including contents, is approximately 6 kg. Current price is estimated at SEK 1,000 (US$ 130.00).

The cold life of the Thermopack has been satisfactorily tested both under laboratory conditions and in the field. The field tests, conducted in collaboration with the national EPI in Tanzania in 1992, monitored the performance of 49 containers filled with EPI vaccines with a guaranteed thermal life of up to 3 months. See summary of test results below. It was noted that some containers lost their vacuum due to damage during transport and that the opening tool needed improvement.

Table 4: Summary of test results on Thermopack system

49 containers opened	100%
difficulties in opening	89.8%
vacuum maintained	91.8%
low vacuum	22.2%
cold inner container	93.8%
warm inner container	6.2%
all ice melted	10.2%

7.2. Thermopack and EPI

Most Technet members felt that the Thermopack is too expensive to be of much use for routine immunization programmes. However, comparative costs can only be calculated if the savings from using Thermopacks are taken into account and also if the vaccine distribution system is designed to operate with Thermopacks from beginning to end. It was pointed out that such an expensive piece of packing should perhaps be designed to have a secondary use after delivery if it cannot be recycled.

Possible applications for Thermopack were discussed, such as:

- Use in areas where a proper cold chain cannot be set up and/or vaccines are likely to be used within a short time after the container is opened, as in emergency immunization activities, war torn zones or where local infrastructure is very weak in countries such as Bosnia, Somalia, Southern Sudan and Tajikistan;
- To reach isolated places such as the mountain tops of Nepal or the desert areas of Mali;
- To transport animal vaccines;
- To transport vaccine in bulk for processing at local production plants;

7.3. On-going activities:

SBL, SIDA and the International Child Health Unit at Uppsala University (ICH), plan to conduct feasibility studies of the Thermopackk system in the EPIs of various countries. WHO/EPI will cooperate in the planning which will emphasise operational and economic aspects and will involve cold chain specialists, logistics personnel and PHC doctors and nurses .

7.4. References:

Working paper: The Thermopack vaccine transport container, Ms. Kersten Fransson, SBL.
Other documents: Results of the Tanzania field trial, EPI/Danida Tanzania.

8. THE IAPSO SOLAR CATALOGUE

IAPSO, the United Nations Inter-Agency Procurement Services Office in Copenhagen, has commissioned the preparation of a catalogue of solar powered (photovoltaic) equipment appropriate for the developing world. The catalogue, which is still in draft form, contains sections for the different types of equipment:

- Water pumping systems
- Vaccine refrigerator and freezer systems (quoted from the EPI/PIS)
- Lighting systems for domestic/clinic uses, lanterns and street lights.
- Rural communications systems (satellite)
- Household and other applications (such as domestic refrigerators, power packs, fencing, extraction fan kits, ceiling fans, etc.)

Each section includes an introductory text followed by data sheets.

This initiative raises the question of the relevance of a Purchase Guide listing equipment which has not been independently tested. There is a risk in listing items and leaving buyers to choose for themselves how to assemble complete systems. A major reason for the number of failures with solar refrigerators in the early days was the fact that refrigerators were frequently supplied without any attempt to match the different components (batteries, charge regulators, etc.). The best solar systems are those which are designed as a whole by a single company which has a thorough knowledge and understanding of the various components and the performance of available models.

The necessary expertise to design complete systems with components from different manufacturers might be available in some countries, but is lacking in the majority of countries which is why WHO/EPI found it necessary to issue recommendations.

Although the IAPSO initiative may need to be strengthened by independent testing of the systems listed, it will raise the general awareness among UN project officers and may be precisely what is needed to make solar a more common technology.

9. BATTERY FREE SOLAR REFRIGERATORS

Development of battery-free systems with better insulated and/or icelined units (to increase the holdover time) needs to be encouraged. This is the only way a breakthrough can be made in the area of solar energy for refrigeration purposes. Battery-free systems should reduce the capital cost and also the recurrent costs for the maintenance and replacement of batteries.

Vestfrost has developed a prototype which was tested at AIT, Bangkok. It did not perform as well as expected in the laboratory tests but performed well in a field test in India. Vestfrost has subsequently changed the design and the new appliance performed quite well during recent tests conducted by the manufacturer. Current plans for the new prototype include:

- a laboratory test at AIT within the next couple of months;
- a controlled field trial of one unit (possibly India or Senegal); and
- securing funds to launch a large scale controlled field trial, with approximately 10 units, in a country committed to the use of solar refrigeration.

10. WORLD SOLAR SUMMIT

UNESCO is organizing a World Solar Summit in July 1993 in Paris: "The Sun in the Service of Mankind" and has invited WHO to contribute a report on "Solar Energy and Health".

The Summit is viewed as a three phase process:

Phase 1: A high level expert meeting to be convened at UNESCO Headquarters on 5-9 July 1993
Phase 2: A Major World Congress, planned for 1994, to approve the plan of action for the "World Solar Energy Decade",
Phase 3: A summit of Heads of State, planned for 1995, for final approval of the Decade.

The preparation of WHO's contribution will be co-ordinated by EPI and it has been agreed that it will be a joint WHO/UNICEF report. Issues covered in the report include:

- Health, energy and rural development
- Application of solar technologies in rural health
- Strategy for implementing solar energy for rural health

11. SOLAR REFRIGERATORS IN INDONESIA

The working paper presented by the Secretariat was not discussed. For a summary, see *Technet News, March 1993*.

12. DEVELOPMENT OF INVENTORY CONTROL SOFTWARE

12.1 Experience of Papua New Guinea

In 1991 Charles Simons, a REACH consultant, assisted the Papua New Guinea Child Survival Support Project and the Papua New Guinea Department of Health Pharmaceutical Services Division, to develop medical supply inventory control management tools. In parallel with this activity he worked on the development of the SLM (Stocks Logistics Module) which was presented at the TECHNET meeting in Casablanca Morocco.

By late 1991 the supply forecasting and reporting modules were installed in all area medical stores with inventory control computers. However, up to the present day, these modules have not been brought into use. There are four reasons for the non-use of the forecasting modules:

- Senior managers became alarmed at the idea of area medical supply officers ordering replenishment of stock items when they reached minimum stock levels. "They will order things all the time!!!" was the complaint.

- It has been impossible to reach any agreement on the meaning of the "AVERAGE MONTHLY ISSUE". This is one of the two key elements required to set-up forecasting. The problem is caused by the storekeepers hoarding and rationing supply items when the stock level of the item is perceived to be low.

- While 'out of stock months' are removed from the calculation, no method has been found to handle low stock levels and rationing. A threshold of 20% of the maximum level was proposed and discarded as it did not reflect storekeeper behaviour. There is of course resistance to the establishment of minimum and maximum stock levels.

- It has not been possible to establish the procurement lead times for each item or even categories of supplies. The procurement system is on the headquarters computer network while the stock movement data is maintained on the separate Area Medical Stores computers. In practice, each lead time would have to be calculated by hand for 1499 catalogue items. As lead times are indispensable for initialising the module, we have reached an impasse.

The establishment of the wide area and remote network later in 1993 will enable the full implementation of supply forecasting in Papua New Guinea.

12.2 Development of Commodity and Logistics Module

After REACH ceased support for SLM, the programme was reviewed and rewritten by Management Sciences for Health (MSH), Boston, for the CCCD project in Nigeria. The new programme, named "Commodities and Logistics Module", or CLM, contains most of the functionality of SLM and improves a number of areas of the programme including export of data to other software, report writing and a better user interface. The first version is now in use in Nigeria and a further developed version is to be tested in Thailand during 1993.

Plans are being discussed between MSH, WHO and USAID to extend CLM from stock control of supplies and vaccines to act as a full equipment and transport inventory for EPI and the rest of PHC.

13. MONITORING RECURRENT COSTS

National immunization programmes and supporting agencies are increasingly focused on strengthening the management of the existing programmes and infrastructures. This effort emphasizes the usefulness of collecting and using cost information as a management tool.

The 4 main questions which need to be addressed on the use of cost information for management action are:

(i) What are the management actions which could be made or improved through better cost information?

(ii) What group/level in the health structure can use this information to achieve the management action?

(iii) What is the cost data needed?

(iv) What is the best system to supply that information?

PAHO has made huge strides in using cost information to improve the management of equipment. Putting the PAHO work into the framework of the four questions listed above provides a different perspective and may suggest ways to take this effort further.

First, PAHO appears to have two different aims for management actions: the selection and financing of equipment and the internal budget support of recurrent costs associated with the equipment. These two aims for management action not only require different information, but perhaps also, different levels/groups to use the information and different data collection systems.

13.1 Management Action (A)

Efficient selection and financing of the optimal type and amount of equipment needed to expand the cold chain and replace old cold chain equipment

Who can act on the information?
Equipment investment: The action will be the result of the Central Level identifying and justifying the request with concerned donors and perhaps the Ministry of Finance/Health

What data are needed? Number, type and condition of equipment in place? Number and type of equipment needed?

Data collection system? Cold chain surveys

13.2 Management Action (B)

Assured adequate recurrent cost budgets to support cold chain equipment

Who can act on the information? It is unclear who will use the data to assure the recurrent cost budgets are sufficient. Perhaps District or Provincial level.

Data Needed? Recurrent costs to support equipment in place (Fuel, maintenance and repair), Per diem and transport cost to less accessible areas

Data collection system? Cold Chain surveys? Perhaps a systematic collection and use of the information within a strengthened budgeting system.

PAHO notes that the recurrent cost budgets do not appear to be increasing, based on the data from the surveys. It will probably be more difficult to strengthen the internal budgeting of recurrent costs than to identify and justify capital expenditure.

However, focusing on building a data collection system to gather this data on a regular basis, and providing training for the district or provincial health sector staff which can use the information may be the most sustainable method to assure sufficient budgets for recurrent costs.

13.3 Next steps

(1) Identify who/what level has the power to make decisions on recurrent cost budgets.

(2) Evaluate existing budget systems for possible ways to collect and share recurrent cost information.

(3) Use information from coverage surveys to identify:
- most important cost information i.e. if 80% of recurrent cost is due to fuel and repairs focus on these two items first.
- possible "rules of thumb": (i.e. recurrent cost per piece of equipment). PAHO surveys indicate the minimum budget necessary to support the cold chain)

(4) Determine if coverage surveys provide general information which can be used for other countries

(5) Determine how frequently the survey data needs to be updated.

13.4 India plans inventory surveys

India is planning to survey existing cold chain equipment with the objective of evaluating the condition of equipment with respect to:

- age
- geographical location
- general maintenance & handling
- quality of electricity
- repair facilities
- quality of repairs
- response-time and down-time analysis
- effectiveness of training

On the basis of the results, India will set a policy for the planned, phased replacement of equipment after ascertaining expected life spans under various conditions.

There is great interest in adopting a standard survey protocol for these surveys and the PAHO survey appears to be an excellent basis for such a protocol.

13.5 Philippines' *Product Information Sheets*:

One key to the success of equipment inventory surveys in Philippines was the production of a small booklet containing a picture and essential details of every model of equipment in use. It was locally printed to help the members of the survey team identify local and imported models of equipment. Once identified, a 'Product Information Sheet' identification number was used in the inventory to economically and un-ambiguously identify equipment in the survey.

Recommendation:

Three standard questionnaires are being developed on the basis of the PAHO experience in this area to date: Inventory of transport and equipment; Recurrent cost questionnaire; Cold chain quality questionnaire

The standard questionnaires are to be tested in Peru and the results discussed among TECHNET members before the EPI Global advisory Group meeting in Washington in October 1993.

14. CRITICAL PATH ANALYSIS (PERT) FOR ACTIVITY PLANNING

One of the strengths of the EPI has been that it operates on the basis of a simple set of instructions universally applied. As with all universal systems, parts of the system can be modified with increasing benefits to particular situations. It is quite likely that the EPI will become more, rather than less, complex in the future as we try to introduce new vaccines, make more efficient use of resources or establish different strategies for disease reduction rather than just coverage.

These complexities may make it beneficial for us to consider training the managers to deal with change and to be equipped to evaluate alternative strategies. A simple version of PERT may be useful for this purpose. When building a large PERT chart, a number of smaller charts are linked together. This makes it possible to build alternative courses of action, each described in a discreet chart, and then evaluate changes in the whole chart when they are inserted one after the other.

CPA is only as reliable as the time estimates which are placed in it. However it is a mechanism to stimulate logical thinking; the tasks needed to complete any activity must be defined and their duration estimated. Tasks must be defined as running parallel to others or in sequence, one depending on another.

Recommendation

Review a range of different proprietary software products for CPA/PERT and make a decision as to which, if any, is the most satisfactory for use in developing countries. If necessary, draft a specification to describe suitable software which might be written for this purpose.

15. PLANNING FOR REFRIGERATION REPAIR SERVICES

15.1. Background

Breakdowns in refrigeration equipment, followed by delays in the process of notification and repair, are probably the most frequent cause of disruption in the supply of vaccine today. Common problems discussed during the conference fall into two categories:

- Inadequate reporting/information/monitoring system:
  - reporting of failures delayed;
  - inadequate inventory systems;
  - no standard stocks of consumables/spares;
  - lack of monitoring repair workload.

- Lack of support to repair technicians:
  - training often too theoretical;
  - secure stores/workshop not available;
  - transport not available;
  - budgets not available for travel/spares.

15.2. Planning workshops to resolve technical, administrative and financial issues

In the experience of India, the *ad hoc* approach to planning maintenance and repair systems seems to have been the root cause of these problems and they have found that systematic state-by-state planning workshops are the key to developing improved equipment maintenance. The courses aim for a goal whereby:

- not more than 3% of refrigeration equipment can be out of order at any time;
- breakdowns must be attended and minor repairs carried out within 3 days; major repairs within 7 days;
- adequate stocks of spare parts and spare equipment in working order must be maintained at each level of the system.

About 35-40 participants, including the Secretary for Health and other senior officials from the Ministry of Health and local equipment maintenance organisations, took part in a workshop which reviewed the existing system

and proposed a specific plan of action[7]. The critical success factor appeared to be the authority of the individual participants to resolve financial, administrative ***and*** technical issues.

Elaborate the planning workshop outline for India to include guides, where possible, to help make the decisions necessary at each stage of the process. The outline and guides should then be incorporated into the senior logistics planning workshop and be made available as a separate manual on planning equipment maintenance systems.

15.3. Potential for assistance to, and from, hospital repair facilities:

UNICEF and WHO/ARI have been working with manufacturers to prepare oxygen concentrators for use in developing countries. This work is nearly completed, and three models from three different manufacturers have been included in the 1993 update of the *WHO/UNICEF Product Information Sheets*. The oxygen concentrator is a compressor based appliance which draws in ambient air, filters it and reproduces it again as 90% oxygen. It is expected to do away with the need to distribute oxygen cylinders to small hospitals and bedded health centres in developing countries. A backup supply of bottles of oxygen will nevertheless be needed in case of failures. It is probably the most important piece of therapeutic equipment in the Programme for Acute Respiratory Infections (ARI) and is certainly the most expensive, costing at a minimum some $US 1,600 per appliance.

UNICEF, New York presented EPI with the challenge of helping to meet the needs for regular repair and maintenance of the oxygen concentrators, without which they will soon fall into disrepair. The following two proposals were put forward:

- Expand the present training given to cold chain technicians in refrigerator repair to include training in the installation, use, periodic maintenance and radical repair of oxygen concentrators and arrange for them to also take care of the concentrators at small hospitals

- Include both the repair of oxygen concentrators and refrigerators in routine training of district hospital repair technicians so that they might also take care of EPI refrigeration equipment in health centres of the same district as the hospital.

Both proposals will be investigated by EPI and ARI in the first countries to receive oxygen concentrators.

---

7 See *Technet Conference Document*, page 132.

16. POLIO SPECIMEN COLLECTION

16.1. Use of the EPID case identification number

It will be particularly complex for managers to implement the instruction to attach a unique EPID number to each case investigation in time for it to be used for labelling specimens. In defence of the adoption of the EPID system for numbering case investigations and to explain the necessity of labelling specimens with this code, the following three points were made:

- Two or more specimens were often sent at different times from the same patient, often with different spelling of the name. It therefore became very difficult to avoid confusion in linking reports to the correct child. As the number of contact stools increased (during the second year of the programme) and as specimens were collected from relatives with similar names, the situation became worse.

- The laboratories received specimens from different sources - some were from 'official' EPI cases and were therefore entered on their line listing; while others were referred by paediatricians who had not yet (and sometimes never) reported them to the EPI. These cases could not be ignored since polio viruses were sometimes isolated from them. When the laboratories and the epidemiologists met and presented their data these never matched. However, once the numbering system was introduced, the laboratories could inform the EPI of any cases without an EPID number. These cases could then be investigated and either accepted as suspect cases or discarded.

- When the weekly parallel Surveillance/Laboratory reporting system was introduced, the numbering system made it possible to reconcile the data and to do specimen tracking.

In the Western Pacific Region, some countries now have polio manuals and forms with space for two numbers; the national polio case ID number and the laboratory number. In these countries the laboratory can refer to both the lab and the EPID number. In larger countries, a third column is being introduced where the provincial ID number can be entered. A province may need to issue its own ID number which will be matched against a national ID number when one can be issued.

The WPR computerized information system includes the province and district as variables. The code provided from national level to WPRO includes only the standard three letter country code. The computer will list cases by provinces or districts, as required, even without a provincial character in the country code. In cases where the province cannot always communicate with the central level before assigning a number, the province will assign its own number, which then needs to be linked with the national number.Co-ordination between laboratories and epidemiological surveillance units has been a problem in the Region, but the situation is improving as this work continues.

16.2. Training modules and instructions

Reacting to the conference document[8] on this subject in which a "trained epidemiologist" is expected to collect polio specimens, a participant observed that *in practice* it is the health workers who collect specimens in many countries so guides and instructions need to be kept extremely simple.

WPRO has prepared simple guidelines on collection, storage and shipment of polio specimens, presented as document WPR/EPI/RPT(2)/92.12 at the Beijing TAG meeting in October 1992. This document includes guidelines on the use of old vaccine carriers and icepacks for the transport of specimens.

Training on specimen collection has been included in polio training courses in WPR, although training does not always reach all persons collecting specimens. Training of all staff on use of the rectal straws is not considered to be practical.

16.3. Specimen collection kits

The requirement for specimen collection kits will increase dramatically as surveillance improves. The cost of the kits ($US 10 each) is emerging as a major problem for WPRO, given present funding levels and considering that all kits need to be purchased centrally (or regionally for many countries).

If two specimens are collected in AFR from all cases as well as some contacts, the number of kits required can increase to more than 500 per year, including reserve stocks, in a country with a population of 60 million.

Participants debated the value of the 3M monitor, which currently accounts for around 30% of the cost of the kit. Arguments against keeping it were that:

8 See *Technet Conference Document*, page 142.

- even if a 3M index is too high upon arrival, the laboratory will still test the specimen;
- the 3M monitor only provides historical data;
- when specimens are being sent only one or two months after the onset of paralysis, this will affect virus isolation even if the 3M reading is perfect;
- although there is a benefit in using 3M index reading to better interpret laboratory results, this benefit needs to be balanced against the cost and the need to import the 3M.

Arguments in favour of keeping the 3M monitor were that:

- during the early stages of specimen collection, the 3M indicator is particularly useful to monitor the standard of handling specimens and to direct supervision to areas where it is needed;
- changing the 3M indicator to the 48 hour type "10I" indicator would halve its price and still meet managerial needs to monitor handling;
- the indicator helps to explain 'no virus isolation' when the laboratory is also monitoring collection/despatch delays.

Relative to cost it was argued that:

- Rectal tubes also account for a large proportion of the kit price. Perhaps a bulk stock of rectal tubes could be kept separate from the kits for use in specific areas or circumstances, thereby reducing the total cost.

- Cost becomes more of a sensitive issue the greater the number of specimens collected for analysis. The cost of kits is relatively low if the number of specimens collected is limited by collecting either:
  100% in countries with very few cases/year (under 50) **or,**
  only a percentage of specimens in countries where polio is more widespread.

Recommendation:

Efforts should be made to reduce the unit cost of specimen collection kits and, based on the experience of WPR, a global training module containing recommended specimen collection, identification and transmission procedures should be developed.

17. TRANSPORT MANAGEMENT

Discussion in this area concentrated on policies for scrapping and resale of donated transport.

Vehicles which are off the road for longer than six months and which lie decaying pending a decision to scrap them exemplify the lack of management control over donated transport which exists in the ministry of health of many countries.

The following suggestions were made to speed the process of scrapping or resale of donated transport:

- decentralise the authority to scrap to region or district administration
- incorporate requests for scrapping within a monthly reporting process which runs up through the system to the central office of the ministry of health
- have the government agree to give the authority to scrap or resell to the donor of that transport
- set criteria for maximum age, maximum mileage and maximum time off-the-road.

All these systems have weaknesses but the consensus appeared to be that the donor has succeeded most often to re-sell transport efficiently and use the funds obtained to purchase new equipment or transport.

18. RUNNING AN ELECTRONIC CONFERENCE

This TECHNET conference was the first to be organised through an electronic bulletin board by WHO and UNICEF.

18.1. Organisation:

The conference was set up on the UNICEF-UNET electronic mail system through a Tradepost bulletin board application written by Ms Chris Brown for WHO/EPI. Invitations to the conference were sent out to those with potential access to UNET together with a manual on the use of the conference in advance. Registrations for the conference were called for by fax or by E-Mail, but they were mainly received by fax.

Several members were assisted to gain access to UNET and UNICEF provided three temporary mailboxes temporarily to be shared among members who did not have their own box. Access for consultants in Europe was provided via local telephone numbers through TYMNET.

The bulletin board menu was organised into categories of subject as shown in Figure.. a week before the official opening of the conference. During this week and throughout the conference, a flyer appeared on the opening screen of the UNICEF UNET menu inviting anyone using UNET to register and participate in the conference.

Table 5: Key to Categories: The conference menu

AA> Domestic refrigerator upgrade	AB> Auto-destruct syringes
AC> Equipment repair	AD> Indigenous equipment manufacture
AE> Injection/sterilization technologies	AF> Injection practice surveys
AG> Inventory/stock control	AH> Jet injector development
AI> Monitoring recurrent costs	AJ> Polio specimen collection
AK> Reduction of CFCs	AL> Equipment failures
AM> Telecomms for surveillance	AN> Riders for health
AO> Solar studies and specifications	AP> Temperature monitoring
AQ> Transport management	AR> Thermopack system
AS> Vaccine needs forecasting	AT> Vaccine supply perspectives
AU> Vaccines out of the cold chain	AV> Any other business????
AW> Participants/documents list	AX> Daily summary of proceedings
XI> Sale of syringes/cards	

Conference documents were collected from the members of TECHNET and posted by the secretariat into the relevant category of the bulletin board and all documents which had arrived within four days of the start of the conference were sent by courier to members with fax communications but without access to E-Mail. These members were also sent, by fax, a summary of the proceedings of each day of the conference and their replies were re-typed and posted on the conference as they arrived.

The daily summaries were also posted on the bulletin board to help participants follow areas of the conference which they had not read in full. Participants were advised to download the documents at the start of the conference and then read or download the unread messages each day in the categories which interested them. Replies could be posted either by uploading a pre-prepared reply or by directly typing on-line.

The secretariat shared out responsibility for categories of the conference among three people who both participated in the discussion and prepared their section of the summaries each day. The conference, which was planned for a period of one week, was extended by popular request for ten days.

18.2. Participation:

The following people participated in the conference by reading, writing or both:

Austin, Glen, PATH, USA
Bass, Allan, Child Survival Project, Papua New Guinea
Batson, Amie, WHO/EPI, Geneva
Battersby, Anthony, Consultant
Bhuyan, A. L., UNICEF, New Delhi
Cain, Nancy, UNICEF, New York
Carib, Nelson, PATH
Erkilla, Mauno, WHO/EPI, China
Evans, Peter, WHO/EPI, Geneva
Frannson, Kersten, SBL, Sweden
Hull, Harry, WHO/EPI, Geneva
Jensen, Ole Moeller, Vestfrost, Denmark
Kennedy, Anthony A., UNICEF, Indonesia
Larsen, Gordon, Consultant
Lloyd, John, WHO/EPI, Geneva
Maher, Chris, WPRO/EPI
Margard, PATH
Muller, PATH
Pierre, Lionel, WHO/EPI, AFRO
Pollack
Pott, John, Consultant
Presthus, Garry, SEARO/EPI
Roussar, Frank, WHO/EPI, Suva, Fiji
Schlumberger, M., APMP, Paris
Schnur, Alan, WPRO/EPI
Spanner, Soren, Consultant
Steinglass, Robert, REACH, USA
Timpson, Andrew, Save the Children, UK
Tsu, Vivien, PATH
Weeks, Mark, REACH, USA
Woodle, PATH
Zaffran, Michel, WHO/EPI, Geneva

The daily activity on the conference began strongly, as indicated by the number of times items were accessed each day, and then increased steadily, with a drop over the weekend (April 3-4) (See Figures 1 and 2). However, writing transactions quickly focused on particular subjects and abandoned others, in some cases completely. This is a true reflection of the focus of the conference being directed towards the subjects of greatest current interest to participants and is a striking benefit of electronic conferencing.

Figure 1: Number of readings per day

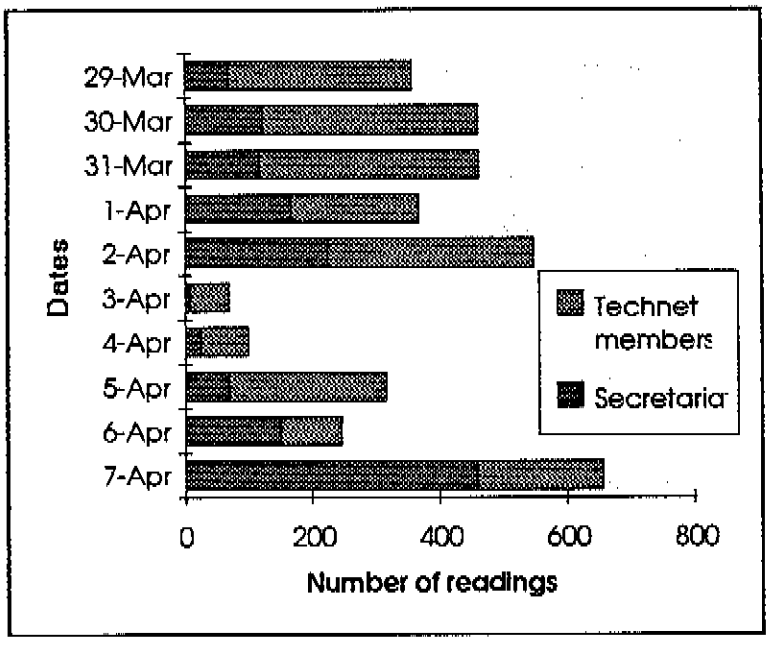


Figure 2: Number of written entries per day

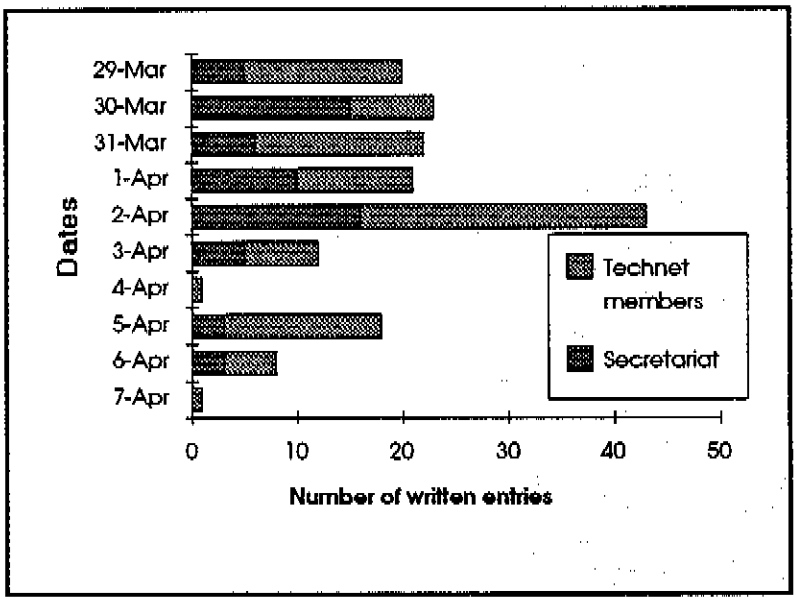


Figure 3: Number of recorded messages per category

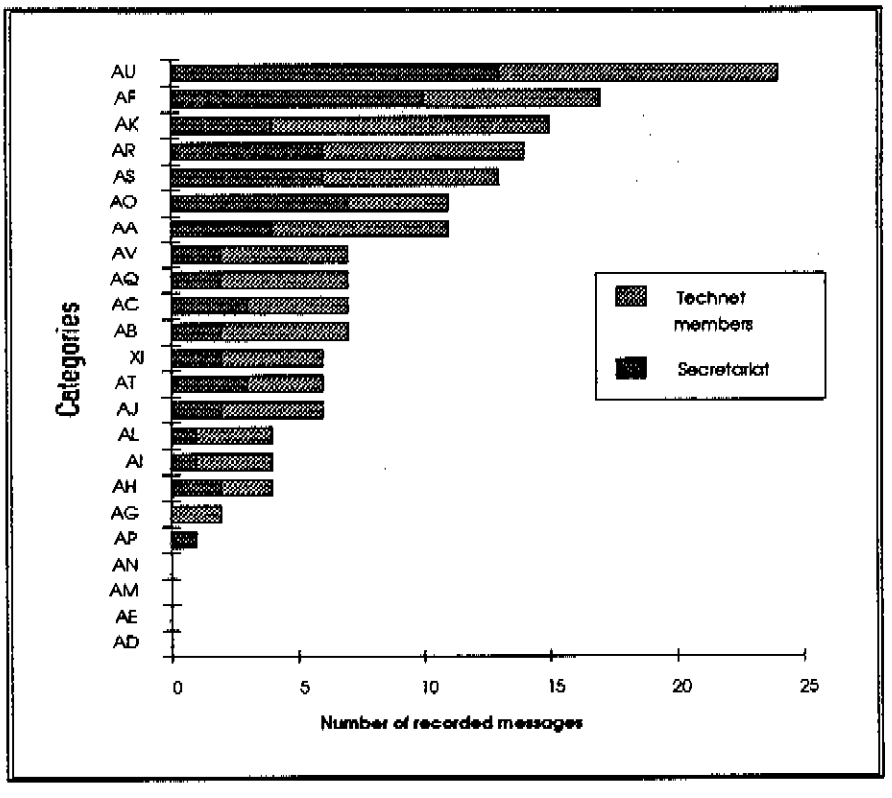
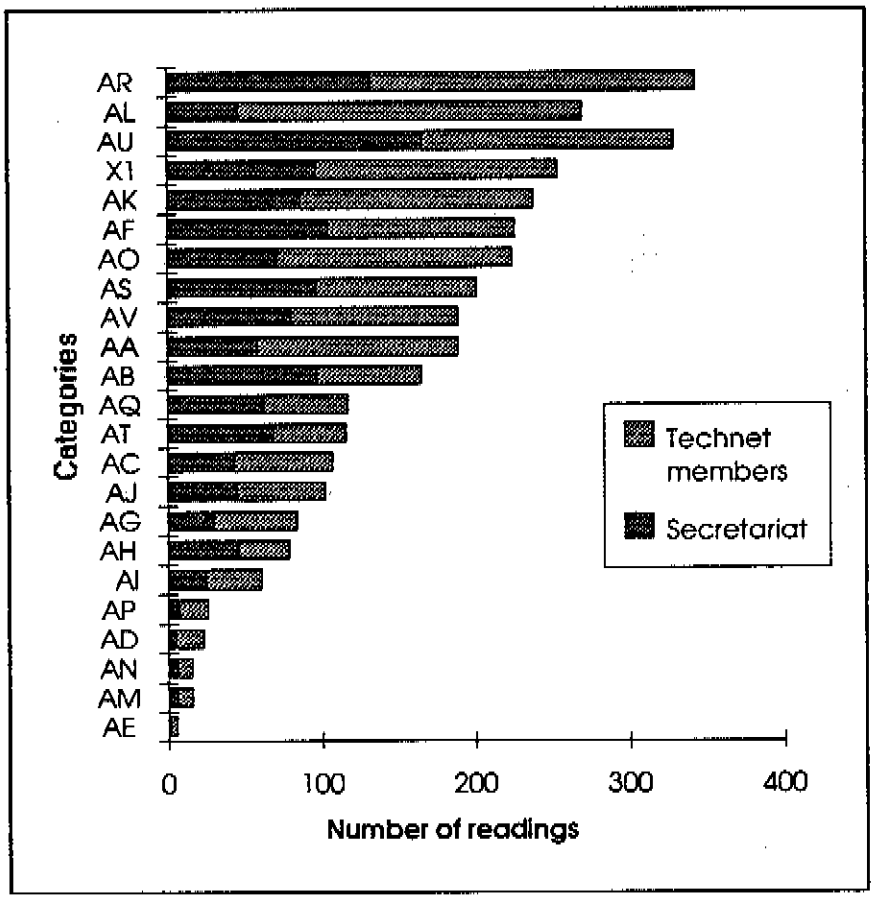
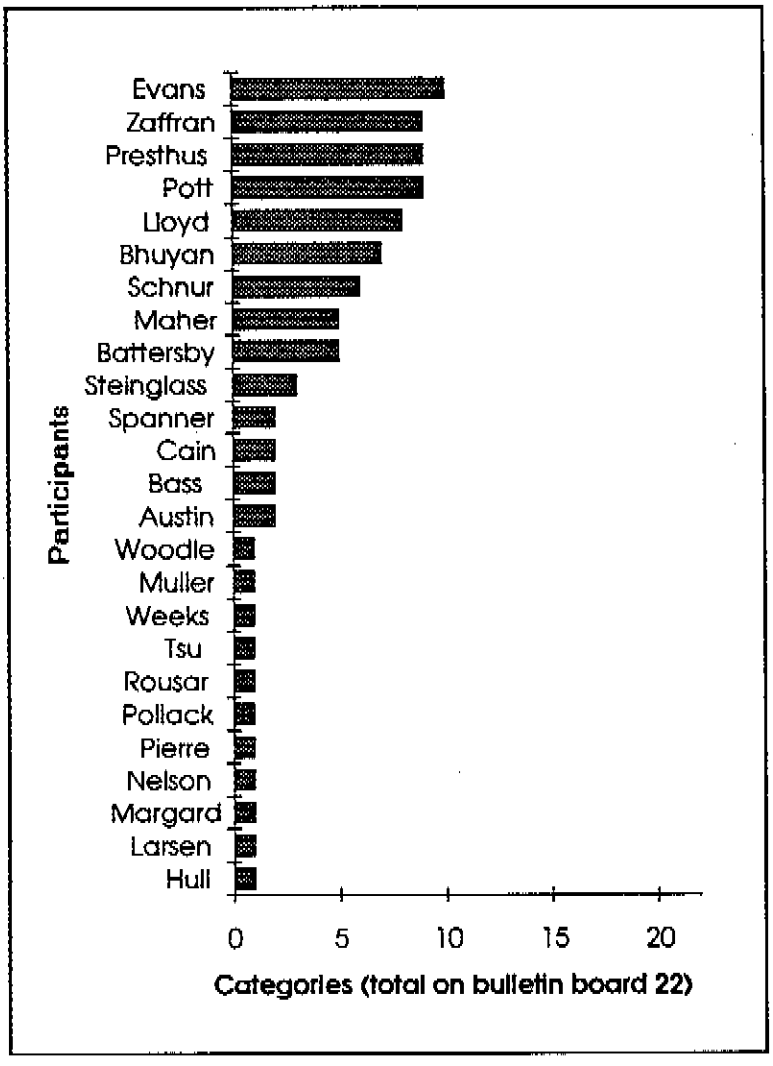


Figure 4: Number of readings per category



Among those categories which remained 'live', the participation of individuals was strikingly biased according to the individual, each focusing their replies, mainly on three or less subjects (See Figure 5). This suggests that 'mini' conferences directed towards specific subjects and with selected participants could expect very high levels of participation.

Figure 5: Conference activity by participant



18.3. Evaluation

Participants were asked to complete a post-conference evaluation form and, although only four questionnaires were completed, the main opinions expressed were generally similar.

The conference was generally considered too short, considering the scope of subjects which were to be considered by participants. The conference should have remained open at least two weeks and preferably a month. There was also the feeling that a narrower focus on a single, or a few subjects would improve the quality of participation.

The techniques of using the bulletin board were not clear to several participants. Better instruction and context sensitive help screen would have avoided the difficulties experienced with scanning, quitting and reading operations. The constant repetition of the menu categories screen was a source of irritation to those who had not understood that a read or a scan statement can contain the category required, thus preventing the menu screen from being repeated. Participants found themselves on line for far too long and costly periods. This was attributed partly to the speed of downloading documents which was considered to be prohibitively slow (2400 baud) and should be speeded up to 9600 baud. Multi-tasking environments such as Windows or Desqview

were considered to be an important advantage, enabling the computer to be used while downloading is under way. Downloading unread messages was considered so cumbersome that people preferred to remain on line, reading directly from the screen so as to follow replies and 'replies to replies'. The appearance of chained messages results in repetition if all messages are downloaded.

Participants who were sharing mailbox numbers were frustrated to find that the system was keeping track of unread messages only by box number, not by individual user. So it was more difficult for the user to discover which messages were new since the last time the user accessed the conference. People felt that, on entry, they should be faced with a 'quick scan' of the messages which had been newly posted. One participant suggested that software should be provided for their own computers which 'managed' their participation. This software would upload and down load automatically and would track new exchanges on the conference automatically preferably, in a 'Windows' environment.

In conclusion, participants felt the conference to be very worthwhile and to be worth repeating. They cited some advantages over other forms of face to face meeting. Documents and comments could be read by other colleagues at country level during the conference, who were then able to participate. Responses were in greater depth than can be achieved in verbal replies and there was an appealing informality and flexibility in participating when it was convenient to do so.

On the other hand, most participants missed the face-to-face contact which is so important in establishing or re-establishing relationships and in understanding the arguments of others. Participating fully in this conference required many hours of on and off-line attention which was difficult to give considering the distractions of the working day. Meeting away from the workplace is considered to be an important advantage to conventional meetings.

Recommendation

Conference software should be modified to recognise multiple participants on the same box number by the use of individual passwords.
"Front end" software should be sought to enable the user to participate off line, leaving the management of on-line time entirely to the computer. Efforts should be made to speed up the baud rate to 9600 so that file transfer is sufficiently rapid.

PART II

CONFERENCE PAPERS

VACCINES...WILL WE ALWAYS HAVE ENOUGH?

Author: Peter Evans, Technet Secretariat

1.0 Background

1.1. During the past decade vaccines have become available to 80% of the worlds children. More than 100 million children receive all of the vaccines given in the global Expanded Programme on Immunization (EPI) each year. In addition 50 million pregnant women receive 2 doses of Tetanus Toxoid vaccine. Vaccine to the value of more than US 200 million dollars were supplied to developing countries by Unicef and PAHO. During the past 10 years the practicality of providing vaccine to all the worlds children has been clearly established. Vaccine is now delivered to more families than is mail.

1.2. The US 200 million dollars, spent annually by Unicef and PAHO, purchased only 50% of the vaccine used. The remaining 50% was produced and paid for within developing countries. 80% of the worlds children are born in countries that produce one or more of the EPI vaccines.

1.3. New strategies of disease reduction, including measles reduction, neonatal tetanus elimination and polio eradication, will require substantially more vaccine than has been required in the past. However, in the past year the prices paid for by Unicef and PAHO for vaccines have increased significantly after several years of relatively unstable prices. The result is that more money is needed for the provision of high quality vaccines. But, who will pay the additional cost?

1.4. To help understand what the current supply systems are, what the future needs for vaccine will be, where they will come from and, just as important, who will pay the bill, it was found useful to examine the world as a whole and to propose a new global strategy for vaccine supply.

2.0 Global vaccine supply strategy

2.1. After the initial analysis it was found that developing countries obtain their vaccines either through local production, from a donor or through purchase from outside suppliers, directly or through UNICEF/PAHO. The mechanism utilized by a country generally depends upon two major factors: its market size and wealth. Countries were therefore plotted on a grid based on their population size and relative wealth (GNP/capita). The world grid was then divided into rational segments based on the following assumptions:

(a) Population size needed to support domestic vaccine production or production sharing.

- Greater than 50 million population: can support local production or production sharing of all vaccines;
- Greater than 10 million population: can support production sharing for some vaccines with Quality Assurance Sharing or some form of external support for quality;
- Less than 10 million population: too small for cost-effective local production without an export market.

(b) Type and degree of aid based on country's relative wealth (GNP/Capita) as defined by the World Bank economic categories.

- Greater than $6000/capita: country should be completely independent from all donor aid;
- Greater than $500/capita but less than $6000/capita: country may require a range of services including flexible credit terms such as accepting local currency, access to procurement services, aid in building government commitment, technology transfer aid in expanding or improving production and quality control capacity, etc..
- Less than $500/capita: country will need continued external financial support.

2.2. These cut-offs create a simple grid of 9 distinct segments which include countries sharing certain abilities and needs in a global strategy map (see Figure 1). Countries which produce vaccine locally are blocked on the map while countries without any vaccine manufacturing capability are blank. The map also highlights the broad development objectives for different countries as well as a general strategic guide for providing support to developing countries by the donor community.

2.3. Looking at the map of countries and their current vaccine supply capacity, it is clear that local production and production sharing of vaccines is widespread. It also appears that countries have been developing their vaccine supply in a relatively rational way with very large countries building extensive local production capacity and smaller countries relying on importation.

2.4. Following is a broad description of types of strategies and donor aid which might be most appropriate for countries falling into the different segments on the map (see Figure 2).

(a) Independent

Segment I: (High Income and Small population countries containing 1% of the worlds children): These countries do not require any aid from the international donor community. Any countries still relying on donor aid should be encouraged to become completely independent in international procurement. This group of countries should not require Unicef or PAHO procured vaccine but should rather procure directly from the manufacturers.

Segment II: (High Income and Medium size population countries containing 2% of the worlds children): Some of these countries have vaccine production capacity which exceeds their domestic needs and export their excess production. These countries contain a mix of public and privately owned vaccine manufactures. In general, the firms have a lower level of R&D (research and development) investment but produce a wide range of vaccines. Supplying the Unicef/PAHO market represents an important part of their business.

Segment III:(High Income and Large population countries containing 6% of the worlds children): These countries have extensive privately owned local production which supply the domestic market and export market both directly and through Unicef/PAHO. Most of the vaccine R&D occurs in these countries in both public and privately funded laboratories. These firms may be very important for future technology transfer/production sharing.

(b) Services for international procurement

Segment IV:(Middle Income and Small population countries containing 3% of the world's children): In the past most of these

countries have received vaccine donations. However, many now view their immunization programmes as being sufficiently important to merit a greater level of country control and independence from donors. In general, however, countries with this population size are too small to support a viable vaccine industry. They might, therefore, be best supported with services which will enable them to become independent in international procurement. These services include access to procurement services, flexible financing terms, help with promoting vaccines as a government priority etc. Many of these services can be found in the Vaccine Independence Initiative, PAHO Revolving Fund and UNICEF Procurement Services.

Segment V: (Middle Income and Medium Size countries containing 9 % of the worlds children): Historically, these countries have also received donor aid and need to be encouraged to become more independent. Some of these countries are large enough to support production sharing (such as bulk finishing) if the local quality control capacity is augmented through external support. In general, quality assurance needs to be strengthened in these countries. Existing production sharing facilities should be strengthened. If production sharing does not appear to be feasible for a given country, the government will be encouraged to use the above procurement services. Morocco is the first country to utilize the facility of the Vaccine Independence Initiative, the revolving fund having been capitalized by USAID. A goal has been set to have at least 10 countries fully participating in the Vaccine Independence Initiative by the end of 1993.

c) Strengthen and expand local production

Segment VI: (Middle Income and Large population countries containing 19% of the worlds children): These 9 countries all possess some level of local production which should be supported to strengthen both quality and capacity, either through primary production or production sharing. Quality Assurance, the most difficult element of vaccine production, should be a major focus. Those countries which are partially independent (e.g. Brazil, Egypt, Indonesia, Mexico, Philippines and Thailand) should be strengthened to full self-sufficiency for the vaccines which they are already producing.

d) Financial support

Segment VII: (Low Income and Small population countries containing 4% of the worlds children): These 20 countries, mostly

in Africa, will need continued donor support in vaccine supply for the coming years. UNICEF and other donors are attempting to secure adequate support for vaccines for these countries. However, countries should be encouraged to begin financing a small portion of their vaccine supply. The goal is for governments to first create a vaccine budget allocation and then to increase it as the country becomes more economically able. The ministers of health of Africa passed a resolution to begin to fund a portion of their vaccine needs (Resolution of the Regional Committee for Africa AFR/RC42/R3).

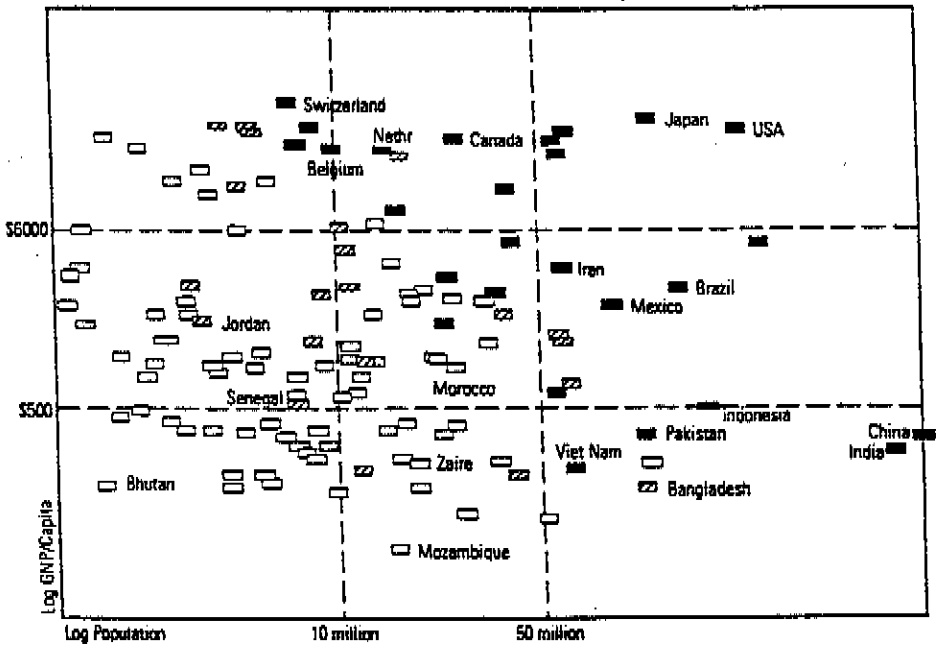
Segment VIII: (Low Income and Medium population countries containing 8% of the worlds children): These 12 countries will need continued donor support but should also be encouraged to finance a small portion of their vaccine supply.

Segment IX: (Low Income and Large population countries containing 48% of the worlds children): The feasibility of self sufficiency with local production is being investigated in 5 of the 6 countries. China and India are nearly self-sufficient in all vaccines. If analysis indicates that the local infrastructure is capable of supporting local production or production sharing then donor aid should be re-allocated to support it. Expanding or building vaccine production and production sharing in these countries will not be a one time investment. Donors should anticipate providing continuous support to these plants for several years. If local production is not feasible for all vaccines, the country will be encouraged to finance as much of the vaccine supply as they are able.

Figure 1: Vaccine supply grid

Independent	Independent	Independent
Procurement Services Provide supportive services in: – Procurement – Management – Financing	**Procurement/ Production-Sharing Services** – Evaluate feasibility of production sharing – Provide supportive procurement service	**Production Services** – Strengthen/expand production as necessary – Strengthen quality assurance
Financing – Continue support – Encourage vaccine allocation in national budget	**Financing for Procurement/ Production Sharing** – Continue support – Encourage vaccine allocation in national budget	**Financing for Production** – Continue support – Evaluate feasibility of production/ production sharing – Strengthen/expand production as necessary – Strengthen quality assurance

Figure 2: Guide to donor aid



The above grid shows the positions of 130 countries (of which only a few are named) differing in wealth (per capita GNP according to the Unicef's State of the World's Children 1991, with cut-off points based on the World Bank's GNP per capita income groups for 1991) and population size (with cut-off points based on, among other things, past experience of the market size needed to support a local vaccine industry). Countries that produce vaccines locally are shaded, either in black for those that produce the viral vaccines, like polio and measles vaccines, or batched, for those that produce the bacterial vaccines, like tetanus toxoid and DPT. Those that have no vaccine manufacturing capability are blank.

THE VACCINE INDEPENDENCE INITIATIVE

Author: Amie Batson, WHO/EPI, Geneva

1.0 Global focus on sustainable vaccine supply

1.1. Vaccines are recognized as an essential and cost-effective tool in assuring child health in all countries of the world. New and improved vaccines are being researched and developed to provide even greater health benefits. With the recognition of the importance of immunization as a strategy for not only today, but also tomorrow, many countries have become increasingly concerned about assuring the supply of the essential item, vaccines. A new global objective is thus:

- to assure adequate quantities of high quality, affordable vaccine for national immunization programmes; and
- to increase each country's independence in the provision of their vaccines through strategies directing each country toward mores sustainable financing and procurement or production practices which suit their particular needs and ensure the best use of funds.

1.2. The optimal supply strategy in each country depends on numerous factors. However, general strategies can be developed and then tailored to the specific needs of each country. The Vaccine Independence Initiative is one such general tool providing a variety of different services to countries.

2.0 Vaccine Independence Initiative (VII)

2.1 Summary

2.1.1. The Vaccine Independence Initiative has been developed to provide countries with services to ensure the regular supply of high quality, low cost vaccine. It is flexible and responsive to the different needs of each country; allowing governments to select what is useful from a menu of services.

2.1.2. The Initiative is intended to: improve the planning and efficiencies of vaccine procurement, improve vaccine related coordination between the ministries of health and finance, allow the country to benefit from the lower prices available to UNICEF, enable payment to be delayed until the vaccines are received in country, and enable payment to be made in either local or hard currency.

2.1.3. The Initiative is currently focused on providing countries with a mechanism to strengthen the procurement and financing of the core EPI vaccines. However, the Initiative also provides a financially feasible and efficient means for introducing new vaccines such as Hepatitis B, Yellow Fever and Japanese Encephalitis into the EPI. The Vaccine Independence Initiative is one more step toward increasing the self-sufficiency and thus sustainability of national immunization programmes.

2.2 Services Provided

The Initiative offers four types of services which can be used by the government to strengthen procurement and financing of the vaccine supply.

2.2.1. Preplanning: Assistance is given to countries to strengthen the forecasting system. The forecasts are used to develop budgets which are included in the ministry of health's annual and long term budgets. A time-table is also designed to ensure that vaccines are ordered every quarter and that these orders arrive in time to avoid stock shortages.

2.2.2. Inter-ministry cooperation: The ministry of health, the ministry of finance, the ministry of planning, and in some countries, other ministries will be included in the decision making. By involving all of these ministries, the ministry of health helps to ensure that vaccine financing and procurement is a shared priority.

2.2.3. Procurement system: The Initiative permits countries to use the UNICEF procurement system, thus ensuring that the country receives WHO approved, low cost vaccine in a timely fashion. Because UNICEF acts as a procurement body for many countries in the world, negotiations with manufacturers are for very large quantities of vaccine and thus the price per vial is favourable. The UNICEF procurement system also ensures that the vaccines are shipped to the country following WHO standards to ensure the potency.

2.2.4. Flexible credit terms: The Initiative is structured around a revolving fund so that the government may pay ***after*** receiving the vaccine. Funds from the revolving fund are used to purchase the vaccine from the vaccine manufacturers. The revolving fund is then reimbursed when the government pays UNICEF for the vaccine order. The revolving fund acts as a line of credit for the government, providing the government with a longer pay back period. The Initiative also accepts both hard and local currency depending on the country situation. If the country has a non-convertible currency, the UNICEF field office can accept local currency as payment for the vaccine and use this local currency to finance the existing programme expenditures.

2.2.5. How does it work?: The following step by step list explains how the Vaccine Independence Initiative would typically function. The details of the Initiative are tailored to the particular needs and circumstances of the country.

(1) Planning, budgeting and agreement on vaccine needs and Initiative structure by all responsible ministries;

(2) Ministry of Health and UNICEF establish quarterly delivery schedule based on vaccine forecast;

(3) Donor capitalizes the revolving fund to cover the country's vaccine need for two quarters (six months);

(4) Ministry of Health places quarterly vaccine request;

(5) UNICEF purchases WHO approved, low cost vaccine through the established procurement system;

(6) Vaccine is delivered to the country with an invoice;

(7) Government pays UNICEF for vaccine in local or hard currency;

(8) UNICEF reimburses the Revolving Fund which provided the credit for the vaccine order;

(9) If local currency was used, the field office would use this currency for existing administrative and programme expenditures.

2.2.6. Progress to Date

Morocco: The Government of Morocco is the first to utilize the services of the Vaccine Independence Initiative. Capital for the revolving fund for Morocco has been provided by USAID. Morocco was the test case allowing UNICEF to identify and establish the necessary internal support for the implementation of this new Initiative.

Africa: The Regional Committee for Africa has passed a resolution (AFR/RC42/R3) urging Member States to take increased responsibility for assuring the financing and supply of vaccines for national immunization programmes.

UNICEF: The UNICEF Executive Board approved the VII and the acceptance of up to $10 million to capitalize the revolving funds. The Division of Financial Management, Supply Division and Programme Division have worked closely together to create Guidelines and the internal system needed to support each country using the VII. Guidelines are available describing the procedures for establishing and using the Vaccine Independence Initiative. A VII contract in French and English has been written which can be used for all countries.

HANDLING OF OPENED VIALS OF VACCINE

Author: Peter Carrasco, AMRO/EPI, Washington

1.0 In August 1992, the Region of the Americas published new recommended guidelines governing the use of opened vials of vaccine, as follows:

- Once opened, Measles, MMR, MR, Rubella, Poliomyelitis and BCG vaccine vials should be discarded at the end of eight hours, even if there is still vaccine remaining in the vial.
- Opened DPT,TD, and Td vaccine vials can be used over a period of five days before being discarded.

2.0 The reason for this change in policy is that AMRO/EPI found that many countries had different practices regarding the use of opened vials of vaccine. For example, some countries kept their toxoid vaccines open for up to thirty days, some stored opened vials of measles vaccines for up to thirty days in the refrigerator and some kept opened vials of polio vaccine from 1-3 days or longer.

3.0 Country representatives at the sub-regional EPI meetings all gave economic reasons for keeping vaccine vials opened, i.e. reduction of wastage rates, independent of vial size.

4.0 This raised concerns in PAHO about the problems involved:

- the possible effects of exposing opened vaccine vials to contamination during the prolonged storage time;
- the reduction of potency due to the many manipulations that an opened vial of vaccine may be subjected to; and
- the economic concerns.

PAHO therefore reviewed the available literature with the aim of producing a set of simple guidelines concerning the use of opened vials of vaccine.

5.0 PAHO's main concerns in drawing up the guidelines were to address the economic concerns of the ministries and to insure that, given the current stability of the various vaccines, no dose of vaccine would be administered which had lost sufficient potency to render it unable to protect the person receiving it.

6.0 PAHO has been monitoring the responses to the guidelines of countries in Latin America and Central America and Mexico. The table below summarizes responses received approximately six months after the new guidelines were issued. This shows that:

- among the 13 countries which provided information, only one keeps open vials of OPV beyond 24 hours;
- all the countries discard measles and BCG vaccines at the end of 8 hours or less;
- only two countries specify that opened vaccine vials TT, TD, and Td can be used for periods up to as long as 30 days.

7.0 The responses received indicate that almost all countries have accepted the proposed norms on opened vials of vaccine. It is not known, however, whether the norms have filtered down to the lowest levels of the health care systems in each country. Many countries say that they have distributed the new norms and will be, or are, incorporating them into their training materials. PAHO will attempt to continue to monitor the extent to which health care services in selected countries accept these norms. PAHO will work closely with countries that have decided to keep opened vials of vaccine longer than the recommended times in order to monitor the safety and efficacy of their practices.

Handling of Multi-dose Vials of Vaccine - Duration of Usage Before Discarding Opened Vial

Country	Vaccines								
	BCG	Measles	DPT	TT.	DT/Td	OPV	HEP-B	Y.F.	HIB
Argentina	8 H.	8 H.	5 D.	5 D.	5 D.	8 H.	8 H.	8 H.	–
Bolivia	8 H.	8 H.	5 D	5 D	5 D	8 H	--	8 H	8 H
Brazil	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Chile	8 H.	8 H.	5 D.	5 D.	5 D.	8 H.	--	--	--
Colombia	8 H.	8 H.	7 D.	14-30 D*	14 D.	8 D.	--	--	–
Costa Rica	8 H.	8 H.	5 D.	5 D.	5 D.	8 H.	5 D.	–	8 H.
Cuba	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dom. Republic	8 H.	8 H.	5 D.	5 D.	--	8 H.	--	--	--
Ecuador	6 H.	8 H.	30 D.	30 D.	30 D.	8 H.	–	–	–
El Salvador	8 H.	8 H.	6 D.	6 D.	–	8 H.	–	–	–
Guatemala	8 H.	8 H.	5 D.	N.A.	5 D.	5 D.	–	--	--
Haiti	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	–	–	–
Honduras	8 H.	8 H.	5 D.	5 D.	5 D.	8 H.	–	–	–
Mexico	8 H.	8 H.	2 D.	2 D.	2 D.	8 H.	--	--	--
Nicaragua	8 H.	8 H.	5 D.	5 D.	–	8 H.	–	–	–
Panama	8 H.	8 H	5 D.	5 D.	5 D	8 H.	--	--	--
Paraguay	8 H.	8 H.	5 D.	5 D.	5 D.	2-3 D.	--	--	--
Peru	6 H.	6 H.	3 D.	5 D.	3 D.	6 H.	3 D.	--	–
Uruguay	7 D.	+	7 D.	7 D.	7 D.	7 D.	--	–	--
Venezuela	6 H.	8 H.	7 D.	7 D.	--	8-24 H+.	--	2 H.	--

* Storage up to four weeks if ambient temperatures less than 25°C.
-- No norm established as vaccine is part normal EPI.
N.A. Data not available.
\+ If OPV vial is handled 10 times or more within 8 hours after opening, vial should be discarded.
H. Hours
D. Days

IMMUNOGENICITY AND PROTECTIVE EFFICACY OF HEPATITIS B VACCINE STORED BEYOND THE COLD CHAIN IN CHINA

Authors: Wang, Shu-Sheng; Xu, Zhi-Yi; Maynard, JE; Prince, AM; Ding, Zheng-Rong; Yang, Jin-Ye; Li, Rong-Cheng; Nong, Yuan-Zhi; Guangxi Anti-Epidemic & Hygiene Station, Nanning, China, Shanghai Medical University, Shanghai, Chine; International Task Force on Hepatitis B Immunization, Seattle, Washington, USA; Long An County Anti-Epidemic & Hygiene Station, Nanning, China.

1.0 In Guangxi Province, China at least 75% of the population has been infected with the hepatitis B virus (HBV), and 16.5% are chronic carriers of HBsAg. In order to effectively control hepatitis B in this region where 80% of infants are delivered at home and where perinatal transmission accounts for one-third of the carriers under the age of 3, newborns need to be immunized as soon after birth as possible.

2.0 The International Task Force on Hepatitis B Immunization, with the aid of a grant from the International Development Research Centre of Ottawa, Canada, has supported a hepatitis B model immunization programme in Guangxi Province, China, since 1988. One of the objectives of the model program has been to compare the effectiveness of HB vaccine between two groups:
- Stored at ambient temperatures and delivered to infants immediately after birth by a village midwife,
- Refrigerated vaccine delivered to infants (first dose) within 24 to 48 hours after birth by a village doctor.

3.0 Ambient temperatures ranged from approximately 15°C to 30°C during the study period. Based on the number of anticipated births each quarter, village midwives are given a supply of vaccine to be kept in their homes at ambient temperatures for up to 3 months. Village doctors go to the district health center to

obtain vaccine stored at temperatures of 4°C to 8°C for administration to the infant within 48 hours of birth.

4.0 The first study group, (Group 1) made up of 358 infants, received vaccine stored at ambient temperatures and administered by the village midwife. The second study group, (Group 2) made up 232 newborns, received refrigerated vaccine from the village doctor. Plasma-derived hepatitis B (HB) vaccine (10 mcg per 1 ml vial) provided by the Beijing Institute of Serum and Vaccine was used throughout the study. It is heat-stable at 35°C for up to 3 months.

5.0 The full vaccination schedule for both groups was dependent on EPI outreach visits at 0,1, and 5 months or 0, 2 and 8 months. Serologic survey were carried out in 1988 and 1989, with serum samples taken from 590 infants 12 months after the first dose of vaccine was delivered. Samples were tested for BHsAg, anti-HB, and antiHBc using RIA reagents provided by the Beijing Institute of Serum and Vaccine.

6.0 Immunogenicity: Table 1 shows seroconversion rates and antibody levels (anti-HBs) elicited after immunization with vaccine stored at ambient temperatures and in at 4°C to 8°C . One year after vaccination the anti-HBs positive rates for Groups 1 and 2 were 81.6 % and 81.9 %, respectively. There was no difference in anti-HBs rates in infants given vaccine stored for up to 90 days at ambient temperatures versus infants given vaccine stored between 4°C to 8°C . ($P < 0.01$).

Table I: Comparison of seroconversion in infants immunized with Hepatitis B vaccine stored at room temperature and in refrigerators in Guangxi Province, China

Group	Mother's HBsAg Status	Number Tested	Anti-HBs Positive		
			Number	%	PN Value
Vaccine stored at ambient temperature	+	55	45	81.8	49.9 ± 9.9
	-	303	247	81.5	84.1 ± 5.4
TOTAL		358	292	81.6	79.4 ± 7.2
Refrigerated vaccine	+	48	36	75.0	95.4 ± 15.1
	-	184	154	83.7	80.5 ± 5.3
TOTAL		232	190	81.9	84.7 ± 9.6

Protective Efficacy:

Table 2 shows the HBsAg+ conversion rates in one-year old infants who had received the vaccine stored at ambient temperatures was 1.1 % (4/358). Similarly, the HBsAg conversion rates in one-year old infants who received the vaccine stored at between 4°C and 8°C was 2.2 % (5/232). In both groups all of the HBsAg+ infants were born to carrier mothers. The protective efficacy rates (PER) were 87.5 % and 75.0 % for Group 1 and Group 2 respectively, showing no significant difference. This indicates that the vaccine stored at ambient temperatures in Long An County, Guangxi Province produced similar efficacy as that of refrigerated vaccine.

Table 2: The Protective Efficacy in Infants of Hepatitis B Vaccine Stored at Ambient Temperature and in Refrigerators in Guangxi Province, China

Group	Mother's HBsAg Status	Number Tested	HBsAG Positive		Protective efficacy rates
			Number	%	%
Vaccine stored at ambient temperature	+ -	55 303	4 0	7.3 0	84.5 100/0
TOTAL		358	4	1.1	87.5
Refrigerated vaccine	+ -	48 184	5 0	10.4 0	77.8 100.0
TOTAL		232	5	2.2	75.0

Discussion: The World Health Organization has stipulated that the simplest and most effective strategy for HBV control in hyperendemic areas is to immunize all infants with HB vaccine. The study described above yields operational data to support the effectiveness of such an approach. HB vaccine can be integrated into EPI and the vaccine can be stored at room temperature and administered by midwives in the home immediately after birth. This allows HB vaccine to be delivered in a timely fashion to those infants born in remote areas. The success of this experience in Guangxi Province, China, has great significance for the control of HBV infection in other developing countries.

DRAFT PROTOCOL FOR A STUDY OF TETANUS TOXOID OUT OF THE COLD CHAIN

Author: John Lloyd, Technet Secretariat

1.0 Background

1.1. Tetanus Toxoid is one of the most heat stable vaccines currently in the cold chain. It can resist exposures up to +45°C for 14 days, up to +37°C for 6 weeks and up to +25°C for several months. However, some TT vaccines are damaged by the action of being frozen one or more times and the flocculation which takes place alters the concentration of vaccine per dose administered unless vigorously shaken before drawing each dose into the syringe. For these reasons, it is global EPI policy to discard TT vaccine which has been frozen.

1.2. Although it is possible to follow vaccine handling procedures which reduce the risk of freezing, in practice many opportunities to freeze vaccine, both in storage and during transport, are created. Recent evidence from Pakistan suggests that in the cooler areas of the country this may be a serious risk.

2.0 Objective

The purpose of the proposed study is to ascertain whether the quality of TT vaccine, which has been removed from the cold chain after national storage and distributed to the field ***outside*** the cold chain, will provide equivalent protection to that which has been kept correctly in the cold chain. If this proves to be the case, the vaccine will be safer kept outside the cold chain, in certain circumstances, than within it.

3.0 Methods

The study will be conducted in two, 3-month phases (1993/1994), during the hottest time of the year in NWFP and Punjab provinces of Pakistan:

3.1. The first phase (1993) will assess the rate of exposure of vials with TT vaccine, kept outside the cold chain. During this phase, sample vials, marked with a heat sensitive chemical indicator, will be distributed *outside the cold chain*. The indicators are set to turn abruptly from grey to black at a threshold temperature of +48C. The sample vials will be carried, out of the cold chain, to every outreach immunization session which is held by ten health units in each of the two provinces. Two health units will be chosen at random in five randomly chosen districts of each province.

3.2. Each vial will travel to one session only and will be marked with the date of that session. If the chemical indicator turns black at any stage of distribution, it will be marked with the date on which the colour changed and stored until the date on which all vials will be returned from the field. None of the vials will be used to give immunizations.

- The second phase (1994) of the study will proceed only if the rate of 'loss' of vaccine in the first phase of the study does not exceed 10%. (Special training to avoid the risk of high temperature exposure will be given in advance).

- In the second phase, TT vaccine will be distributed to the same health units, again with chemical indicators attached. Some vaccine vials will be distributed *outside the cold chain* and others will be distributed *within the cold chain*. Both types of vials will be used to immunize women of child bearing age who are not pregnant. Women will be allocated to two groups; those who receive TT which has remained within the cold chain and those who receive vaccine which has been kept outside the cold chain. Blood will be taken from women in both groups before immunization and one month after the first dose of TT vaccine. Sera will be tested for the presence of antibodies.

- Any vials of vaccine which are found to have a black indicator, indicating that they *have been exposed to extreme temperatures, will not be used* but they will be marked with the date and kept. Those which do not have black indicators and which have been used will be placed in the health unit refrigerator. This will enable

them to be counted correctly, later. All vials will be collected from the health units at the end of the study.

4.0 Materials

Assuming that one immunization session takes place each day, six days per week in the outreach activities of ten health centres per province over a period of three months, 1500 vials will be needed for the first phase of the study. These vials will be specially labeled and fitted with a marker provided by WHO. A similar quantity will be provided for the second phase.

5.0 Reporting

At the end of the first phase, the vials are collected and the proportion of vials whose indicators have changed colour will be counted, both in total and for each study area. In the second phase, this data and the data on the serological response of the vaccines will be analysed.

INJECTION PRACTICES IN PAPUA NEW GUINEA

Author: Allan G. Bass, Child Survival Project, Papua New Guinea

1.0 Introduction

1.1. Papua New Guinea (PNG) provides primary and secondary health services for it's population of nearly 4,000,000 through a network of around 1700 rural Health Aid Posts, 20 Provincial Hospitals, and 2 referral hospitals. Twenty semi-autonomous provinces operate almost all health services. About 85% of the population lives in rural areas -highlands, riverain lands, forests, and islands. Distances are large, roads are few, and access is difficult.

1.2. Injections are a popular means of treatment, preferred by both the public and health workers alike. The success of antibiotic injections for the treatment of yaws, and Pig-Bel Vaccine have virtually eliminated these previously common diseases. PNG was one of the earliest countries to join in the EPI.

1.3. In 1989 the WHO recommendation on the use of a single sterile needle and a single sterile syringe for each dose for each client was adopted as national policy. Reusable glass syringes are the only syringes supplied to health facilities. Hospitals and health facilities near hospitals rely on sterilization using the hospitals' autoclaves. Most health centres use pressure cooker types of steam sterilizers. Health Posts use 'fish kettle' boiling trays for sterilizing injection equipment, regardless of altitude.

1.4. In 1989 and 1990 the WHO\UNICEF reusable plastic syringe and sterilizer system was introduced in about half of PNG. Unfortunately the system was introduced without appropriate training. As a result the syringes were used as disposables and the sterilizers were never used.

1.5. Papua New Guinea has reported a total of 129 confirmed cases of HIV infection in 12 of its 20 provinces by the end of 1992 (with substantial under reporting). Sexually transmitted diseases reported from 18 sentinel clinics appear to be high. Serological surveys have indicated Hepatitis-B carrier rates as high as 25% to 35%. It is estimated that between 30 and 35 million injections are given in PNG annually.

2.0 Injection practices

2.1. In late 1990 and in 1991 the writer conducted a survey of EPI operations including injection practices. Among the findings was the universally observed re-use of syringes from dose to dose and client to client. The standard practice in all health facilities is to change the needle between patients, while using the same syringe for at least one day.

2.2. A typical health facility would have 5 syringes in use for immunization and 2 syringes in use for other injections. A separate syringe would typically be used for mixing diluent. A survey in early 1993 demonstrated that health facility stock levels of glass syringes were adequate for the use of separate syringes for each injection and were not the cause of these dangerous practices.

2.3. When syringes are "sterilized" they are wrapped in paper (usually computer or typing paper). A trial conducted by the writer using TST indicators in steam sterilizers showed insufficient steam penetration. A similar trial in hospital autoclave packs demonstrated that while the outside of the pack was exposed to sufficient steam at high temperature, the paper wrapped syringes and wrapped instruments did not attain the minimum necessary steam exposure. (The autoclave operators felt that the indicators were at fault).

2.4. At Aid Posts the use of 'fish kettle' boiling trays is problematic at best. More than 700 aid posts (estimated) are located at altitudes above 1000 meters, and some of these are as high as 2000 meters. The efficacy of boiling at these higher altitudes is in doubt. A limited number of glass syringes along with reusable and disposable needles are used in Aid Posts. Additionally the common practice of mixing boiled and used syringes in the 'fish kettle' boiling tray serves to maintain contamination.

3.0 Interventions

3.1. At the last Technet meeting in Casablanca it was proposed that PNG would participate in an early trial of the WHO EPI 'Injection Practices Survey' using WHO's recently developed survey protocol. It was hoped that the survey would help the PNG Department of Health more clearly define the extent of the problem so that the poor injection practices already seen could be shown to be a serious problem of international concern. In the event, the proposed survey was caught in a jurisdictional dispute between WHO/Geneva and WHO/WPRO, and in the end aborted.

3.2. Following this a proposal was developed by the Child Survival Project and the PNG Institute of Medical Research to carry out the WHO EPI 'Injection Practices Survey' along with a simulation of the re-use of syringes (as is done in PNG) using human volunteers (as the source of contamination only) to estimate the actual risk of contamination of injection equipment with Hepatitis-B virus. A research protocol is in draft and will be submitted for funding by USAID in the next approvals cycle.

3.3. In 1992, medical and technical opinion was clearly favouring a change from re-usable glass syringes for all injections to the universal use of disposable plastic syringes: all in the name of safety. Abscesses on the injection site are frequently reported by health workers. AIDS is seen as a growing threat - a time bomb - with injections given by the health system leading to accelerated infection rates.

3.4. In an effort to provide a rational basis for (and to delay) any decision on the use of disposable syringes, the writer proposed a six month trial in 10 health centres and one provincial hospital in New Ireland Province and in the Surgical Unit of the National Hospital in Port Moresby. The objectives of the trial were to evaluate: the costs, the delivery system, usage, disposal procedures, the control of stock, and the training requirements. This trial is now halfway to completion. It is already clear that controls on syringe disposal and the control of syringe stocks is failing in over 20% of the facilities in the trial. It seems likely that a recommendation for a change to reusable plastic syringes - and steam sterilizers - will be made.

3.5. In Papua New Guinea, any change in technology or practices must be introduced with a massive training effort. The recent failure of both solar technology in the cold chain and the

introduction of reusable plastic syringes and sterilizer systems demonstrated this training need. No health worker training or refresher training systems are operated by the Department of Health (DOH). To have any effect at least 3 staff from each health centre, more from hospitals, and all Aid Post Community Health Workers must be trained. This amounts to some 3000 health workers to be trained in a small, high cost, country with few training resources. It is estimated that the changeover costs including hardware and training, will be in the range of US$ 800,000.

3.6. At the end of 1992, the issue of injection practices was brought to the attention of Ministerial Level 'Ministers' Task Force to Review the National Department of Health'. The task force made the following recommendation: "Training of all health workers in infection control and equipment must be funded and conducted. The adequate funding of syringes and sterilization equipment for all levels of the health delivery system must be assured. Supervision must be regularized and improved."

3.7. The disposable syringe trial and, hopefully, the injection practices survey will be completed in 1993. Real solutions might become operational in 1994 and 1995.

AUTO-DESTRUCT DISPOSABLE SYRINGES AND NEEDLES

Author: Peter Evans, Technet Secretariat

1.0 Introduction

1.1. A new type of syringe, the auto-destruct syringe, has been developed to ensure that injections given within the EPI remain amongst the safest injections in the country. An auto-destruct syringe operates like a standard disposable syringe but is rendered unusable after a single injection, despite efforts by the user to reuse it.

1.2. Programmes that choose to use disposable syringes but cannot assure that the syringes and needles will be disposed of after a single use should supply only auto-destruct syringes.

1.3. Programmes requesting disposable syringes from UNICEF will receive only auto-destruct syringes once such syringes become generally available.

1.4. As far as possible the auto-destruct syringes look and act like a conventional syringe. There are, by necessity, some restrictions on the design of the syringe.

1.5. The maximum capacity of the syringe will be equal to the dose to be given. It will not be possible to draw in more than one dose except for a slight overage to allow for trapped air to be removed and for the dose to be then adjusted. As the syringe is designed to give only a standard dose, the markings on the barrel will be at zero and one dose only. The syringe will have a fixed needle 23 gauge, 25 mm, with cap.

After one dose has been given, the syringe cannot be refilled and another injection given.

1.6. The syringes will be provided in boxes which can be used to contain the syringes and needles when they have been used. The box will resist needle piercing, can be sealed effectively and can be used for the final disposal of the syringes either by burning or burying.

1.7. Programmes that regularly use sterilizable syringes sometimes require large quantities of single-use syringes for accelerated efforts or campaigns. As the routine programme is accustomed to reusing syringes and needles, auto-destruct syringes should be requested for the accelerated efforts or campaigns to prevent the used single-use syringes from accidentally entering routine programmes.

2.0 Disposable syringes and needles for single use

2.1. Disposable syringes and needles are often not destroyed after a single use but are reused. Disposable syringes which have been discarded, but not destroyed, may find their way into less formal systems of health care where sterilization practices may be non-existent.

With the successful development of the auto-destruct syringe which can ensure safe injection practices the use of conventional disposable syringes and needles should be discouraged

3.0 Contaminated syringe box

3.1. Single-use disposable syringes must be safely disposed of after a single use. When the needle and syringe have been used for an injection they are contaminated and represent a potential health hazard. The health worker giving injections is most at risk.

3.2. Immediately after use, the syringe and needle should be placed, by the health worker, into an easily accessible container that will provide protection from the risk of an accidental needle stick injury and will prevent contamination of other equipment or working surfaces.

The health worker has the responsibility to ensure that the contaminated syringe and needle cannot injure anybody.

3.3. Single-use syringes and needles should be placed in this container without recapping the needles. Once single-use needles and syringes have been placed in the container they should not be

removed. When the box has been filled with single-use needles and syringes it should be sealed and used for the final disposal of the contaminated single-use syringes and needles. Final disposal can be by burying or burning. If there are no final disposal facilities at the health center, then the box should be a self contained incinerator, capable of burning the syringes outdoors without the need for any additional fuel.

4.0 Recapping procedures

4.1. A high percentage of needle stick injuries occur when the health worker tries to recap the exposed and contaminated needle. If there is a secure container designed to accept discarded needles and syringes the needle should not be recapped. If such a container is not available and the syringe is to be discarded, either into a temporary container or a container that will not prevent needles from sticking through the walls, then it is safer to recap the needle. *The hand must never move in front of and towards an exposed needle.*

4.2. Simple equipment is available which will allow for the needle to be recapped using a one handed technique. At the very least the cap can be placed on the table. The syringe and needle are held in one hand while the other hand is held behind the back. The cap is picked up by inserting the needle into the cap and raising it up. The cap can then be pressed firmly into position.

5.0 Pre-filled device

5.1. Pre-filled devices may offer a convenient way of giving injections in a variety of situations. Simplicity of use of these devices raises the possibility of their use by auxiliary health workers. Such ease of use will have a high price. The present cost of these devices is too high for them to be considered for routine use in the EPI.

JET INJECTORS

Author: Peter Evans, Technet Secretariat

1.0 Introduction

1.1. While millions of injections have been given safely with traditional jet injectors, disease transmission by use of jet injectors remains a theoretical possibility.

1.2. The principal advantage of the traditional jet injectors is the high speed at which large numbers of people can be immunized. As these jet injectors can usually only be used with one vaccine, a separate jet injector is required for each vaccine. Traditional jet injectors are prone to failure and require skilled technicians to repair and maintain them.

1.3. Jet injectors must be sterilized at the end of every session. The head must be cleaned by wiping after use. If the head becomes contaminated by blood it should be replaced immediately by a sterile head.

2.0 Low workload jet injector

2.1. A new concept of jet injector for use in low workload situations has recently been shown to be possible. When available, such units will be able to inject multiple 0.5 ml doses and will be as safe in use as a sterile needle and syringe. They will be easily cleaned after use and will have heads that are easily removed for sterilization if splashed or otherwise contaminated. They will provide increased patient comfort. They will be portable and self contained, easy to operate and maintain, able to use standard multiple dose vaccine vials and able to use the same jet injector with many vaccines. The per injection cost should be lower than a standard disposable needle and syringe.

CFCs AND THE NEW GENERATION OF REFRIGERATION EQUIPMENT?

Author: Gordon Larsen, Short Term Consultant, UK

1.0 Introduction

1.1. The CFC (chlorofluorocarbon) and HCFC (hydrochlorofluorocarbon) group of compounds were once considered the ideal refrigerants; non-toxic, non-flammable, very stable, and possessing a range of pressure-temperature relationships suitable for a huge variety of applications. Recent concerns about their effects on the environment, however, have changed this view to such an extent, that the entire group is to be phased out and banned from use in the very near future.

1.2. These concerns stem from two main phenomena: ozone depletion and global warming.

2.0 Ozone depletion

2.1. The discovery in the early-1980's of a hole in the earth's stratospheric ozone layer over Antarctica, and its suspected linkage to emissions of chlorine gas, led to adoption of the Montreal Protocol in 1987. Under this protocol, nations agreed to limit their production and consumption of certain chlorofluorocarbon and halon gases suspected of causing the environmental damage, and to phase out their use entirely by the end of the decade.

2.2. The prime gases affected by this agreement were the CFC's, with HCFC's being considered a lesser hazard and usable as "transitional" gases until better, chlorine-free replacements could be introduced. The main CFC and HCFC gases currently used, and the proposed chlorine-free HFC replacements are shown in Table 1 below.

2.3. Society, however, depends heavily on CFC's and halons for refrigeration, insulation, fire protection, and the production of a wide range of industrial and consumer products (See Table 2 below). An agreement to phase out such important compounds was no simple proposition. Producing and introducing acceptable alternatives would take much time and effort.

2.4. By 1991, however, solution of the problem was seen to be more urgent. A further assessment noted that "new scientific evidence continues to reveal more rapid depletion of the ozone layer than was previously predicted", and that "depletion was increasing at significant rates over the densely populated northern hemisphere."

2.5. A new, accelerated timetable for control of CFC's was agreed in December 1991, under which an 85% phase-out of all CFC's was to be achieved by January 1995, with complete phase-out by July 1997.

This timetable has now been shortened even further. Parties to the Montreal Protocol met again in November 1992, and agreed on an 85% CFC phase-out by the end of 1993, and complete phase-out by 1st January 1995. In addition, the HCFC's are no longer considered acceptable as "transitional" gases, and immediate replacement is recommended.

2.6. One likely consequence of this rapid phase-out timetable is a period of acute shortage of CFC's for service and repair of existing equipment, a problem which will affect particularly the developing countries where much of Technet's efforts are concentrated.

3.0 Global warming?

3.1. The "greenhouse effect" is increasingly seen as a problem of similar importance to ozone depletion. Many substances, in addition to CFC's, contribute to this effect, the largest being carbon dioxide, which has long accounted for some 55% of total warming. The contribution of CFC's however, has risen from zero in the 1940's to some 24% today. The replacement of CFC's could help reduce global warming, although reducing CO_2 emission is more difficult, due to widespread dependence on fossil fuels as a primary energy source. The Global Warming Potentials (GWP's) of the CFC's, HCFC's and replacement HFC's are also shown in Table 1.

Global warming effects of using a refrigerator come from two sources:-

- The "direct effect", due to loss or leakage of the CFC's or HCFC's from a cooling system or the insulation material; and

- The "indirect effect" of the carbon dioxide produced when generating energy to operate the system.

3.2. The former can be minimized by using a replacement HFC and preventing all possible losses and leaks, and the latter by using a "low energy" compressor. For a domestic refrigerator using an HCF for both cooling system and insulation, it is estimated that 98% of its global warming would come from energy generated CO_2, and only 2% from normal loss of refrigerant. This, however, implies careful use and servicing and that all measures must be taken to collect and re-cycle the working fluid.

4.0 A new generation of compounds and equipment?

4.1. Most of the HFC compounds listed in Table 1 are now under development and some are already available. By far the most urgently needed is a replacement for CFC 12 (R12). Not only does this gas account for 85% of all refrigeration use but, as shown in Table 1, it is also one of the most harmful of the CFC's. From the Technet perspective, virtually every item of cold chain equipment on earth uses CFC 12 in some form, either as a refrigerant, as a foaming agent for insulation, or both. The compound of choice to replace CFC 12 is HFC 134a, although HFC 290 (propane) is also strongly supported in some quarters. HFC 134a has a similar pressure-temperature relationship and similar energy consumption rates to CFC 12. Provided the original compressor oil is changed to an ester-based lubricant, HFC 134a can be used as a direct replacement gas in a compression refrigerator or freezer.

4.2. This compound is now available from a number of suppliers and Danfoss domestic compressor units, specifically designed to use HFC 134a, are already in production. Vestfrost have announced that all refrigerator and freezer products will use CFC-free insulation as from June 1993, and that changeover to HFC 134a compressors will be made by mid-1994. Other producers of cold

chain equipment are expected to follow this trend with increasing urgency as the deadline for a 100% CFC phase-out approaches.

4.3. For existing equipment, CFC and HCFC compounds already in the cooling system may continue to be used, but careful servicing can make a major contribution to reducing further emissions. Recovery and reclaiming of used gases is essential, and a number of schemes are already available in Europe and USA to ensure re-cycling of used refrigerants. The pool of re-cycled CFC's is limited, however, and after production ceases, the switch to replacement HFC refrigerants will be imperative.

5.0 The future

5.1. The time has come to move away from environmentally harmful CFC's and HCFC's. There will soon be no supplies of these gases remaining, even for servicing of existing equipment. New compounds and new equipment are becoming increasingly available, and the means to effect an orderly changeover are being provided.

5.2. But challenges facing designers, producers and users of refrigeration equipment, and not least Technet members, are still numerous. How to achieve an efficient transition from using the old gases to the new? How to ensure safe management of existing equipment and prevent leakage of more CFC's to the environment? How to collect and re-cycle CFC's from cold chain equipment in far-flung corners of developing countries? And since most refrigerators and freezers used for cold chain purposes contain no more than a few hundred grammes of CFC at most, is the effort of collecting and re-cycling really practicable ?

5.3. But whatever the responses and solutions to these questions, the most favourable timetable for implementation of the inevitable transition is the one that begins today.

Table 1: Properties of principal fluorocarbons

Refrigerant No/Type	Boiling Point	Ozone Depleting Potential	Global Warming Potential
CFC 11	+24°C	0.0	0
CFC 12	-30°C	0.0	3.1
CFC 113	+48°C	0.85	0.3
CFC 114	+4°C	0.7	4.2
CFC 115	-39°C	0.4	9.8
HCFC 22	-41°C	0.05	0.37
HCFC 123	+27°C	0.02	0.02
HCFC 124	-12°C	0.02	0.1
HCFC 141b	+32°C	0.09	0.09
HCFC 142b	-9°C	0.06	0.37
HFC 32	-52°C	0	0.13
HFC 125	-49°C	0	0.61
HFC 134a	-27°C	0	0.29
HFC 143a	-48°C	0	0.77
HFC 152a	-25°C	0	0.03

Table 2: Worldwide Consumption of CFC's - 1988 (K Tonnes)

	CFC11	CFC12	CFC113	CFC114	CFC115	Totals
Refrigeration	35	295	1	2	6	349
Aerosols	85	00	3	8	-	96
Foam-closed	80	60	4	2	-	246
Foam-open	90	0	1	2	-	03
Solvents & other	20	20	236	2	-	279
	410	485	245	6	6	172

DOMESTIC REFRIGERATOR UPGRADE KITS

Author: Mauno Erkkila, Alan Schnur, Chris Maher

1.0 Background

1.1 A number of countries in the Western Pacific Region have purchased and will continue to purchase many thousands of domestic refrigerators for storing EPI vaccines. There are a number of important advantages to using domestic refrigerators. These refrigerators and their spare parts are readily available and no foreign currency is required for their procurement. They can be purchased even at sub-national level using local funds. Repair and maintenance is also usually easier than for imported equipment.

1.2 There are, however, some disadvantages in using these refrigerators as far as the maintenance of recommended vaccine storage temperatures is concerned, particularly in case of power failures. In view of this, laboratory tests on domestic refrigerators have been conducted in Colombia and Australia, with the aim of developing a simple modification kit that can be installed in the field on an assortment of refrigerators in use.

2.0 Developments

The laboratory tests have basically focused on two aspects: increasing the thermal mass by using water-filled containers; and adding insulation either inside (door and use of insulated containers) or outside the refrigerator. The results are encouraging and demonstrate a significant improvement in the temperature distribution and hold over time of a domestic refrigerator. However, some of the designs tested may not be that easily repeatable under field conditions. For instance, ideas such as adding insulation in the door or the outside surfaces of a refrigerator and manufacturing wire baskets for holding icepacks fall into this category. However, other modifications, such as increasing the thermal mass and using simple insulated containers inside the refrigerator, may be more practical.

3.0 Future directions

3.1 While the laboratory test results to date have been promising, it is most unlikely that a universal domestic refrigerator upgrade kit will be available in the near future. Possible ways of utilizing the laboratory data available so far, either immediately or in long-term, are discussed below.

3.2 Modifying refrigerators to improve performance national level EPI authorities should be informed of findings in relation to the use of domestic refrigerators for EPI purposes and of ongoing efforts to upgrade the performance of these refrigerators.

3.3 Although some further tests would be needed, it is obvious that the hold over time of a single door refrigerator could be considerably increased by placing icepacks (or other similar plastic containers) inside the refrigerator in accordance with the following guidelines:

(a) Keep as many icepacks as possible in the freezer compartment of the refrigerator. However, fill the freezer compartment over a period of several days and do not freeze more than 4 - 6 icepacks per day.

(b) Place a layer of icepacks filled with cold water in the drip tray underneath the evaporator provided that, after placing the icepacks, there is at least 10 mm space left between the evaporator and the icepacks.

(c) Adjust the upper shelf of refrigerator so that there is a space of 120 - 150 mm between the shelf and the drip tray above it. Place three layers of icepacks filled with water on the shelf, leaving an air space of 20 - 30 mm between each column of icepacks, as well as between the icepack columns and the walls of refrigerator.

(d) If the refrigerator has a vegetable compartment, fill it in with icepacks filled with water and leave the cover (glass shelf) out so that air can freely enter/exit the compartment.

(e) If there is no vegetable compartment, place 5 to 6 layers of water-filled icepacks on the bottom of the refrigerator.

(f) It is important that sufficient time is allowed (24 to 48 hours) to stabilize the temperature in the refrigerator compartment at about +4°C before storing vaccines.

3.4 The use of insulated boxes inside the refrigerator has shown promising results in laboratory trials conducted by Murdoch University Engineering Research Institute (MUERI), in Perth, Australia. Holdover time was lengthened considerably by the combination of increasing the thermal mass and using an insulated box, as shown in the Table below. (Source: MUERI Report October 1992). Trials are now necessary to test different modifications in field conditions.

3.5 Two-door refrigerators are widely used in the EPI cold chain and many of the new models manufactured are of this type. Some laboratory test results, however, indicated that modifying these refrigerators to increase holdover time is more difficult than modifying single door refrigerators. Further studies are needed to identify means for improving the performance of two door refrigerators but, in the meantime, parts of the above guidelines can be observed as far as they are applicable.

4.0 Preparation of a manual

Based on the experience of country level tests and/or field trials, a manual should be prepared with step-by-step instructions on the simplified modification procedures. The manual should be distributed to EPI staff.

5.0 Long term solutions

5.1. Most probably some of the refrigerator manufacturers in developing countries could be convinced that there is a market for reasonably priced refrigerators, meeting the performance requirements of EPI. This market would not be limited to the needs of the health sector but could include ordinary users of refrigerators in areas with unstable power supply. In this respect, an ideal type of equipment would be a two-door refrigerator with an adequate freezing capacity and some 200 - 250 litres gross volume.

5.2. In countries such as China and India, where large numbers of refrigerators are manufactured, the performance specifications for domestic refrigerators used by EPI should form a part of the national cold chain equipment standards. As above, the local

refrigerator manufacturers will have to be approached and persuaded to consider the modifications required. In countries where refrigerators are not manufactured, practical modifications will need to be undertaken by local staff, according to the guidelines determined by field trials.

6.0 Conclusion

In summary, there are means to upgrade existing domestic refrigerators at any time with the materials (icepacks) available everywhere. There are also promising indications that other simple modifications, such as insulated containers (simple cold boxes), could increase holdover time. To confirm the applicability of laboratory results, some further trials at the country level would be required and a simple modification manual will have to be prepared. As for long-term solutions, efforts should be made to introduce modifications at the manufacturing stage of domestic refrigerators. The sharing of a brief summary of the laboratory tests and their results with manufacturers would be very useful at the initial stage of negotiations.

Table: Summary of holdover time tests with insulated box inside refrigerator

	At 32°C			At 43°C		
	Temp. inside the box at the start		Hold-over time	Temp. inside the box at the start		Holdover time
Description of setup	Max °C	Min °C	(minutes)	Max °C	Min °C	(minutes)
Unmodified refrigerator:						
• Post-repairs	-	-	-	-	-	8
• Pre-repairs	-	-	-	-	-	30
Unmodified refrigerator	4.5	2.7	113	8.4	7.0	39
• with large box			pre-repair	7.3	6.2	70
Water storage at bottom; ice storage below freezer; no door insulation						
• Large box	4.9	2.9	182	8.3	7.0	51
• Small box	2.6	1.6	137	6.1	4.8	78
Water storage at bottom; ice storage below freezer; door insulation						
• Large box	4.2	2.3	207	7.3	6.4	98
• Small box	2.8	1.7	157	5.7	5.0	86
Water storage at bottom; ice storage below freezer; door insulation; icepacks in box						
• small box	2.9	1.8	174	5.9	5.0	99
Water storage at bottom; ice storage below freezer; water storage in door						
• small box	1.8	0.6	204	5.6	4.2	77

INDONESIA - EXPLOSION OF FCW20 KEROSENE FREEZER[9]

Author: Kennedy, Anthony A., UNICEF, Indonesia

1.0 Introduction

1.1. On 2 February 1993 an Electrolux FCW-20 freezer exploded and burned the interior of the Health Centre at Bandar Sungai, Riau Province, Sumatra, Indonesia.

1.2. In 1990 UNICEF purchased 3,400 FCW-20 freezers using supplementary funding provided by Rotary International. The Bandar Sungai FCW-20 freezer was one of 2,645. Technet participants may recall that 17 Electrolux RCW-42EK exploded, burned down Health Centres, and in one case, killed the Health Centre doctor. Indonesia demanded both design modifications on the RCW-42EK and compensation. Also the Government placed an embargo on the importation of the FCW-20 freezers. This embargo was lifted only after assurance by Electrolux that the FCW-20 freezers had a different design from the RCW-42EK.

1.3. Last week, Mr. Pierre Juchemes, Technical Manager, Electrolux, Luxembourg, a UNICEF colleague and project officials visited Bandar Sungai. According to their observations, the real cause of the fire and explosion are not known at this stage. However, the fire may have started because the flame and the glass chimney were out of place and possibly heated other parts of the freezer.

1.4. The Health Ministry official responsible has directed staff to stop the use of FCW-20 freezers using kerosene pending further developments. This will affect around 2,500 FCW-20 freezers and will cause major problems for the cold chain system. The GOI Project Manager is informing WHO of the event and the action taken.

[9] Adapted from an E-mail received from Unicef, Indonesia.

1.5. The initial Electrolux reaction has been that staff were not operating the freezers properly and need to be trained. This was the same reaction that Mr. Juchemes had a couple of years ago when the RCW-42EK refrigerators exploded. The Project Manager disputed Mr. Juchemes' conclusion *then* and he disputes the same conclusion *now*. The project feels that the FCW-20 freezer has a design flaw.

2.0 Comments by the Technet Secretariat

Two further fires have been reported form Indonesia since this document was prepared.

2.1. The problem with the RCW 42 EK refrigerator was identified as having been caused by a series of aggravating factors (*Technet Newsletter*, March 1993) factors was the burner modification kit which increased the power of the burner; another factor, however, was inadequate user training.

2.2. The fact that after all the RCW 42 EK in Indonesia have been modified, the country reports one fire with another model shows at least, that the RCW 42 Eks are now operating properly.

2.3. The FCW 20 freezer operates with the Aladdin 32 burner which has been used on kerosene refrigerators for many years. It has not been modified recently.

2.4. During a visit to Electrolux by EPI/HQ staff, a video of the Bundar Sungai health centre, after the fire, was shown and Electrolux described a series of tests they are conducting in an effort to try and identify a design flaw.

As of 15 March 1993, no conclusions could be reached either by EPI/HQ or by Electrolux. The following information, however, is worth considering:

(a) The freezer was started for the first time on the day it exploded. It operated without problems from approximately 7:00 am till 2:00 p.m. when the health centre staff left. The explosion took place at approximately 4:00 p.m. that afternoon.

(b) The video and the police report (pictures) clearly show that the freezer was placed against a wall (in a corner) with the burner against the wall.

(c)The video shows that the bottom part of the Health Centre wall was concrete, while the upper part (approximately from the top of the freezer) was made of wood, or something similar, which has burnt.

(d) Tests performed by Electrolux to see whether the burner, set at its maximum, could actually set fire to the appliance proved negative. Under certain conditions (with the burner tilted) the heat which is radiated can start melting the polyethylene of the refrigerator wall (melting point for the plastic is 120°C for the tank and 90°C for the walls). Tests have shown, however, that the material or the foam will not actually burn unless there is an open flame (flame point is about 340°C). Radiated heat is not sufficient to start a fire.

(e) Tests also performed on the appliance operating kerosene and electricity at the same time also proved negative. This possibility was envisaged as some health centre use both sources of energy and switch from one to the other (30% kerosene/70% electricity). The appliance has actually received approval from the official German inspection body, TUEV, for operation of gas and kerosene and electricity at the same time.

(f) The quality of the kerosene was checked and found to be very good.

2.5. More tests are being performed as follows:

- with the appliance placed against a wall:
  - burner set to heavy sooting;
  - measurement of temperatures along the side of the refrigerator , (against the wall, from bottom to top) to see whether they could set fire to the materials of the wall (wooden part);
  - burner set to heavy sooting and two energies used;
  - burner set to maximum.

- with the appliance not placed against a wall and the burner set to maximum with air draft and burner glass in different positions.

2.6. Although the possibility of a design flaw still needs to be investigated, one possible explanation could be that the freezer, being placed against the wall (touching it), overheated. The heat of the chimney gases may have subsequently caused the upper part of the wall to burn or perhaps something fell from the ceiling on to the top of the chimney. This is pure speculation, however,

since the proximity between the wall and the burner certainly *appears* to have been an aggravating factor.

Electrolux will finalize these tests and will present an explanation and a proposal to the MOH/Indonesia by the end of March 1993.

ELECTROLUX RCW42 EK REHABILITATED FOR ROUTINE USE IN EPI

Author: Michel Zaffran, Technet Secretariat

1.0 Introduction

In articles published in *Technet News* (August 1992) and the *Cold Chain Newsletter* (October 1991), the problems which had occurred with Electrolux RCW 42 EK kerosene refrigerators were described. Mr Gordon Larsen, Technet member, has now completed his review of the situation in Indonesia. The conclusions of his report[10] confirm that the RCW 42 EK, as modified according to Electrolux recommendations, is now safe for use in EPI:

2.0 Summary of events

2.1. During 1990-1991 several fires and explosions were reported in Indonesia, at health centres using the RCW 42 EK refrigerators.

2.2. The events were investigated by Electrolux and, after several attempts to find an explanation, the following factors were found to contribute to a risk of fire that eventually led to the explosion of the cooling unit:

(a) The refrigerator makes use of the "burner modification kit" which increases the power output of the burner. This kit is composed of 2 metal mesh inlets, fitted at the centre of the Cosmos 8 burner, and one larger mesh part with a metal ring. This larger mesh part is also fitted in the middle of the burner, with the metal ring at the base.

(b) The Cosmos 8 burner may present a leak.

[10] Printed subsequently in *Technet News*, March 1993.

(c)The baffle may cause an accumulation of soot which, combined with the increased power of the burner, causes fire.

2.3. A "refrigerator upgrade kit" was designed by Electrolux and distributed to all the countries that have purchased either the burner modification kits alone or RCW 42 EK with the burner modification kit installed.

3.0 Main conclusions of the review

- All the refrigerators inspected had been modified with the refrigerator upgrade kits supplied by Electrolux.
- No fires have occurred with the newly modified refrigerators. Some fires have been reported but, according to the Ministry of Health, they concern older, non-modified models.
- The new modification works fine and operating the refrigerator with it is therefore safe.

Table: Main findings of inspection

Refrigerators working	95%
Temperature correct	50%
Too warm	20%
Too cold	10%
Not reported	15%
Refrigerators modified	95%
All parts correct	60%
No flame guard	20%
Mesh ring upside down	10%
Baffle not removed	5%

4.0 Description of the RCW 42 EK upgrade kit

The kit contains the following

- a new tank, with a red cap (instead of the old black one);
- a new burner (with a red knob) with the metal mesh rings;
- a metal shield (which needs to be installed at the lower-front-right hand corner of the refrigerator, close to the burner): it can easily be fitted by using the screws that hold the refrigerator legs;
- a new instruction booklet marked "MODIFIED" with a red stamp;

- a new user's poster marked with a "modified" red stamp.

NOTE: The baffle ***must*** be removed from the chimney.

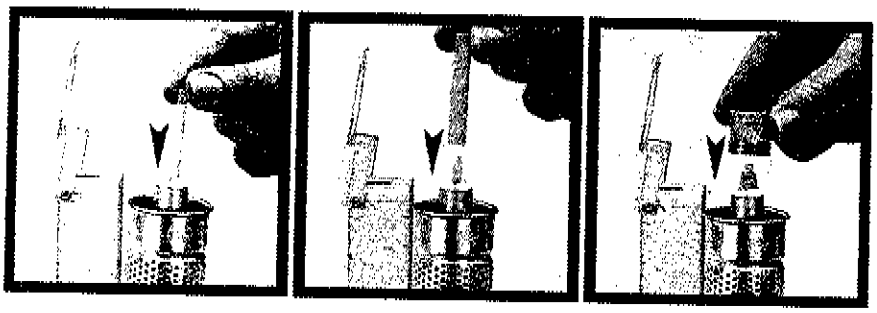
5.0 Conclusions

5.1. Unicef and WHO have agreed that the supply and operation of the RCW 42 EK refrigerator cane resumed, provided that it is fitted with the above modifications (paragraph 4 above) and that the users are properly trained.

5.2. Under no circumstances should the burner modification kit (3 metal mesh inlets) be used/installed on a Cosmos 8 burner unless the refrigerator is completely modified as per paragraph 4 above.

5.3. The RCW 42 EK has been reinstated in the *Product Information Sheets.*

5.4. **If you are using a RCW 42 EK refrigerator and the burner is fitted with metal mesh inlets (see photo below) *and* if you do not have the complete upgrade kit described above, please urgently contact Unicef, WHO/EPI or Electrolux.!!!**



FAILURE OF ICE LINING REFRIGERATORS/FREEZERS

Author: A.L.Bhuyan, Unicef New Delhi

1.0. Introduction

More than 3000 Electrolux TCW-1151 and 9000 Vestfrost MK-140 ILRs were installed in India from 1985 to 1990. Till end 1993, out of 9101 MK-140 ILRs 1324 were reported beyond repair due to internal leak in the evaporator (14.5%).

During this period, similar un repairable leakage developed also in other models of ILR/Freezers, but they are observed to be comparative low. This can be observed from the table below :

- Electrolux, TCW-1151 3.1%
- Vestfrost, MK-140 ILR 3.4%
- Vestfrost, SB-140 Freezer 0.9%
- Vestfrost, SB-300 Freezer 0.3%

2.0 The problem

2.1 The problem is attributed to a design defect, viz. use of steel tubing in the evaporator. The evaporator and the condenser tubes of the MK-140 ILRs and freezers are made of steel. They are laid on the inside surface of the inner and outer wall of the cabinet and PUF insulation is injected between them. When a leak occurs in these tubes, they therefore cannot be repaired and hence the unit becomes unserviceable.

Some leaky units were opened for examination. The evaporator tubes were corroded in these units in many places. The corrosion was seen to have started on the pipe portions from behind the joint of the inner tank and then spread to other areas.

2.2 When the equipment is working, there is a chance of moisture in the air going in through the joint mentioned above and getting deposited on the evaporator tubes as frost. In places where the power supply has frequent interruptions, or equipment gets cut-

off by the stabilizer due to low supply voltage, the deposited frost melts and the rusting process starts.

Water from any broken/leaky ice-pack (for ice-lining) may also contribute to the frost formation. It has been observed that the problem is more acute in the costal states. Also, out of the leaky units, approximately 45% developed leaks within 2-3 years of service; about 18% in 1-2 years and 28% in 3-4 years of use.

Corrosion due to moisture and the amount of moisture penetration may depend on many factors, including :

- Quality and duration of storage and transportation before installation;
- How long the equipment is in use;
- Environmental conditions (humidity, presence of other chemical if installed in/near the chemists room, pollution etc.);
- Quality of power supply;
- Frequency and duration of opening;
- Quantity of moisture already entered before the sealing of the joints;
- Quality of maintenance by the user.

3.0 Preventative action

In studying the defects, it was observed that the manufacturers had sealed the joints of the inner tank of all the units working in the field, as well as those awaiting installation. This may be expected to elongate the life, to some extent, of the appliances sealed before installation. However, it is doubtful if it will prevent further deterioration in models already effected.

To avoid re-occurrence of the problem in this particular model, the manufacturer was requested to provide copper tubes in the evaporator, and units manufactured since October 1990 are fitted with copper tubes. The units confirmed to be beyond repair are being replaced with new ones (with evaporator of copper tubing).

4.0 Recommendation for discussion

At present only the *'performance* specifications' of equipment are being taken into consideration. It is desired that WHO/UNICEF should also draw up some important ***technical*** specifications, such as material, minimum thickness of materials etc. giving special consideration to the field conditions in the tropical

countries. If possible, the expected life of the equipment assured by the manufacturer should also be mentioned. This is required mainly for programme and replenishment planning.

CURRENT STATUS OF VESTFROST ICELINING REFRIGERATORS, ICE-LINING FREEZERS AND ICEPACK FREEZERS

Author: Ole Moeller Jensen, Vestfrost, Denmark
Paper presented by Peter Carrasco, AMRO/EPI

1. At the end of 1992 the total number of Vestfrost appliances supplied to India was approximately 45,000; to Bangladesh approximately 2,000 units and some 6,000 units to 16 other countries. Reports on problems with leaky ice-lined ***refrigerators*** (ILRs) have been received from India and Bangladesh only. No faults have been reported, however, from any country with the ice-lined freezers (ILFs) or the ice-pack freezers.

2. The production of ILR's started in 1987 and the first reports on leaking evaporator tubes reached Vestfrost in October, 1990. The production was immediately changed over from steel tubes to copper tubes and, since October 1990, all appliances for WHO and UNICEF have been produced solely with copper tubes.

3. Problems with leaky evaporators arise in areas with a high air humidity and frequent power failures where the humid air can penetrate to the evaporator tubes. In addition to using copper tubes we now also seal the joints of the inner tank.

4. Vestfrost have supplied 9800 ILR's with steel tubes to India. The first 2200 units were delivered in 1987 and, apparently because they were installed in states with a lower air humidity, had only few power failures -- only 1 (one) fault was reported with the 1987 production. Of the remaining units, Vestfrost have replaced 1300 ILR's in India and 150 in Bangladesh for Unicef.

5. It has been arranged with the local authorities in India and Bangladesh that the rating plates of the leaky ILR's are cut off and sent to UNICEF in Copenhagen. From the serial numbers of the

rating plates Vestfrost can find out how long the appliance has "lived" and new appliances are forwarded against a charge of 20% per year after expiration of the period of guarantee.

6. Vestfrost was established 30 years ago as a chest freezer factory and is today Europe's largest manufacturer of chest freezers. Through the years a total of ten million appliances (refrigerators and freezers) have been produced - 609,700 units in 1992 alone. All these appliances have been manufactured with steel tubes and naturally without problems. Vestfrost have learnt, however, that ILR's are to be produced with copper tubes.

PROBLEMS WITH ELECTRIC ELEMENTS FOR SIBIR 240GE/KE REFRIGERATORS

Author: Michel Zaffran, Technet Secretariat

1.0 Causes of the problem

Several countries have reported a high rate of failure with the electric heating elements in Sibir refrigerators. After having completed tests in Sweden, Sibir are now confident that they have identified the probable cause of the problem:

- Heaters of any voltage for the old Sibir Model S2325 PEV1ST (Kerosene/Electricity) and S2323 2V1 (Gas/Electricity) give no problems. Failures can occur with high voltage fluctuations but this is not due to a defect in the burner.

- A defect has been identified in heaters made by a sub-contractor for both current models V 240 KE and V 240 GE. This has now been taken care of as Sibir started producing the heaters themselves in February 1993. The defect from the sub-contractor's product caused a high rate of burn-out of the heaters.

2.0 Recommended action

For quick identification, the "low grade" heater manufactured by the sub-contractor has its end crimped in the shape of a half moon; the heater manufactured by Sibir has an end crimped into the shape of a star.

Countries reporting high failure rate with the electric elements of models V240 GE and KE should contact WHO/EPI or the local Unicef office.

THERMOPACK VACCINE TRANSPORT CONTAINER

Author: Kersten Fransson, SBL-10521 Stockholm, Sweden

1.0 Introduction

The Thermopack system for storage and transport of temperature sensitive substances was developed in corporation with the Linkping Institute for Technology, Sweden. The stage of development has now reached a point where the Thermopack can be used for several purposes. Future development work is aimed at adapting the container to specific fields of application.

2.0 Description of the Thermopack system

2.1. The transport container, made of stainless steel is sealed with the vaccines and a certain amount of ice. With a very high quality vacuum insulation its design enables it to maintain a temperature between 0 and 8°C for a theoretical limit of up to 180 days.

2.2. It is a disposable container and, once it is opened, the contents have to be used immediately (depending on the stability of the vaccines.

2.3. The storage temperature can be varied between -20 and +4°C, depending on the choice of cooling substance. Ice as the substance gives a temperature close to 0°C .

2.4. The first Thermopack plant was inaugurated in November 1992 at the National Bacteriological Laboratory (SBL), Stockholm-Sweden, by the Swedish Minister for Development Assistance.

2.5. The following is a specification of the system at SBL:

Transport temperature:	0°C
Maximum container contents:	approximately 50 x 10 dose vaccines vials
Thermal life:	up to 90 days at ambient temperature of +32°C

Keeps cold:	up to 12-24 hours after opening, depending on amount of ice left in the container.
Dimensions:	
Height:	305 mm
Outer diameter:	240 mm
Total weight:	approx. 6 kg, including contents
Contents:	possible to include appropriate combination of vaccines
Current price:	estimated at SEK 1,000 each (approximately US $ 200).

2.6. Thermopacks in different sizes and materials, depending on cold life required, are being envisaged. SBL estimates that prices could drop to approx. SEK 200 - 400 each.

3.0 Testing

3.1 The Thermopack has been tested under laboratory conditions and field conditions in Tanzania EPI, both with fully satisfactory results as to the cold life. In the Tanzania test, carried out in 1992 in collaboration with EPI, 49 containers with EPI vaccines and a guaranteed thermal life of up to 3 months were tested and monitored.

3.2 A summary of test results showed:

Containers opened 49	100%
Difficulties in opening	89.8%
Vacuum maintained	91.8%
Low vacuum	22.2%
Cold inner container	93.8%
Warm inner container	6.2%
All ice melted because of damage during transport	10.2%

3.3. Some of the containers lost their vacuum because they had been damaged during transport. This problem is being solved with a better packing and packing method. It was also concluded that the opening tool needed improvement.

4.0 Future plans for the Thermopack system

4.1. Attempts have also been made to use the Thermopack system in the Life Line Sudan, but it seems that the civil unrest has made it

impossible. Thermopacks are now made at the SBL in Sweden and are readily available.

4.2. There is great interest from SBL to see how the Thermopack system can complement and to some extent improve the existing cold chain system e.g. in areas where vaccines are needed for relief operations and in areas with difficult access.

4.3. SBL, SIDA and the International Child Health Unit, ICH at Uppsala University are planning to conduct feasibility studies of the system in EPI programmes. The planning is still in a preliminary stage, but the intention is that the studies will emphasize operational and economic aspects and will involve cold chain specialists, primary health care doctors and nurses, logistics personnel, etc. Contact is being made with WHO/EPI in the near future for discussions on the design of the studies, methods, etc.

4.4. Of interest is also, that the Department of Immunology of the SBL will use the Thermopack for transport and storage of HIV-reagents and tests in different countries under systematic follow-up.

SBL and SIDA are most interested in further studies on this novel device and they will request WHO/EPI to comment on the study protocols.

5.0 Comments by the Technet Secretariat:

The report of the Tanzania field trial can be shared with anyone interested. Please request a copy from the Technet Secretariat, WHO/EPI/Geneva.

The Thermopack system was presented to Technet members more than two years ago and most of the comments at that time focused on the following issues:

- How can this system be used in routine immunization programmes?
- What will be the cost of the system, including the initial investment required to set up the packaging plant?
- Where will the packing take place?

- The container cannot be reused but can it be recycled?

- When the container is opened, vaccine have to be used. The system, therefore, does not appear to replace the need for a cold chain. Could it, however, contribute to "short-circuiting" some of the steps?

- The system appears to be very well adapted to emergency an relief situations such as refugee camps where mass immunization is envisaged and there is no time to set up a cold chain. Is Unicef purchasing "thermopacked" vaccines for mass campaigns in Somalia?

FIELD TRIALS OF UNIVERSAL THERMOMETER IN COLOMBIA

Author: Michel Zaffran, Technet Secretariat

1.0 Introduction

The Universal thermometer was described in the March 1992 issue of *Technet News*. Field trials in Colombia and Tanzania have now been completed. The Tanzania results are not yet available but the trials of the two units installed in Colombia have provided very useful feedback. The Colombia trials were conducted under the supervision of the Universidad del Valle, Cali, Colombia.

2.0 Results of the trial

Energy source: The appliance operates very well with its small solar panel charging the battery (Guapi).Operation on mains current, even with as much as 6 hours of power cut every day is also very successful (Montebello)

Data: The user of the refrigerator only needs to use the temperature reading function. Trying to train the user to use the other modes (such as indication of the time that the refrigerator is below or above certain thresholds) only causes confusion.

The alarm: Connected to the Unitherm, the alarm operates very well and its meaning is understood by the staff

Usefulness: As a tool for supervisors, it provides a reliable means of keeping track of what happens with the refrigerator since the previous visit.

3.0 Future plans for the Unitherm

Some modifications are required - for instance the probe can be calibrated by mistake when checking the temperature; this should be avoided.

Once the final reports of the two trials are finalized, WHO/EPI, Unicef and the manufacturer will discuss ways to implementing this technology widely in the cold chain.

IAPSO CATALOGUE OF SOLAR EQUIPMENT

Author: Soren Spanner, Short Term Consultant, IAPSO, Copenhagen, Denmark

1.0 Introduction

There has for some time been an interest from IAPSO (Inter-Agency Procurement Services Office) in Copenhagen to contribute to the safe environment. After some initial meetings it was decided that a catalogue of solar powered (PV) equipment appropriate for the developing world be prepared. The terms of reference were as follows:

- Compilation of technical data and price information on commercial solar powered equipment.
- Evaluation of data and assessment of equipment for use in development projects.
- Cost/benefit analysis of prominent equipment items.
- Inspection/quality control of major items
- Consultations with major UN Agencies on recommended solar powered equipment.
- Preparation of data sheets for selected items to form an IAPSO project catalogue on Solar Powered Equipment for Development Assistance.

2.0 The role of IAPSO

- to assist the UN system to procure at the lowest possible cost consistent with the maintenance of adequate standards;
- to obtain process and disseminate timely and reliable information on business opportunities, notably in UNDO- assisted projects, to the business community and, as appropriate, to governmental organizations;
- to standardize common-user equipment giving adequate weight to the life-cycle cost of an item, its durability and its suitability to local conditions in recipient countries;
- to identify new sources of supply, particularly from under-utilized major donor and developing countries, thereby creating

an expanded and more equitable geographical distribution of sources for UN procurement;

- to assist suppliers to obtain better access to UN-system procurement;
- to increase utilization of UNDP holdings of accumulated non-convertible currencies by identifying products and services available in countries with such currencies;
- to negotiate with private insurance companies with a view towards the development of various global insurance schemes for the benefit of UN organizations;
- to obtain special discounts and collect relevant information on transport, including ocean and air-freight, for the UN-system;
- to undertake procurement upon explicit request on behalf of UN organizations, governments, organizations cooperating with the UN-system, and staff members, for common user items.

3.0 Preparation of the Catalogue

Potential suppliers of PV equipment were contacted and requested to supply all available information, including indicative prices, on their range of products. Since IAPSO were looking for well proven and documented products, suppliers were requested to provide supporting information such as test results and a reference list. The information received was examined and data sheets produced, the sheets were returned to the company for verification.

The following sections make up the contents of the Catalogue:

- **Water pumping systems**
- **Vaccine refrigerator and freezer systems:** The EPI/PIS were taken directly from the EPI/PIS with no changes apart from a few updates and corrections.
- **Lighting systems:** Domestic/clinic lighting systems; Solar lanterns; Street Lights
- **Rural communications systems:** Satellite communication systems
- **Household and other applications:** Domestic refrigerators; Power packs; Man Packs; Solar powered fencing; Extraction fan kit; Ceiling fans

Each chapter starts with an introductory text and examples of use etc. Due to time constraints the chapter on communication is very limited; it still needs to be updated and expanded.

4.0 Distribution

The catalogue will be distributed to UN headquarters, Resident Representatives and interested personnel. A stock will be held at the IAPSO office in Copenhagen. The contact person at IAPSO is Senior Technical Officer Mr. Peter Adler Tel.: +4535273700 Fax.: +4535273799.

5.0 Time frame

The catalogue is now being set-up and the first draft should be ready late April when it will be sent to WHO/EPI and UNICEF for comments; the final edition will probably be ready in June 1993. Comments and/or suggestions to the catalogue are very welcome.

SOLAR REFRIGERATORS IN INDONESIA

Author: Michel Zaffran, Technet Secretariat

1.0 Introduction

Using part of a World Bank loan, the Ministry of Health in Indonesia has procured 100 solar powered refrigerators to improve the storage of EPI vaccines in peripheral health centres. These provide a greater degree of reliability and enhanced vaccine security as compared to conventional cold chain equipment. The equipment was procured with the technical assistance of Unicef and has been installed throughout 10 provinces, covering generally remote areas where regular access is difficult. Work on this programme started in early 1991 and most installations have now been functioning for more than 12 months.

2.0 Review

A review, focusing on the quality of installation, the training of the users and the operational status of the units, reached the following conclusions:

- Design and sizing of systems has been correct and project implementation has been satisfactory.
- User training, carried out during the installation has not been effective. As a result, routine equipment maintenance is not being done adequately,
- 33% of the installations reviewed were either not working at all (mostly due to damage during transport to the sites: refrigerant leaks) or were not keeping correct temperatures (damaged thermostat boards).
- There is a serious shortage of spare parts and a very important lack of supervision and reporting. Minor faults therefore eventually result in serious breakdowns.
- As compared to conventional equipment, cost analysis shows that solar refrigerators have higher life cycle costs, a higher installed capital cost but lower operational costs.

- WHO/UNICEF guidelines on solar refrigerator implementation have not been adequately followed. Most of the shortcomings observed could have been avoided had these guidelines been used as recommended.

UPDATE ON INVENTORY AND STOCK CONTROL SOFTWARE

Author: John Lloyd, Technet Secretariat

1.0 Introduction

1.1. Stock control of vaccines, supplies and spare parts is among the simplest procedures to computerize and offers the greatest benefits in raising the efficiency of storekeeping, for the least maintenance effort. Inventory control of equipment throughout a network of health institutions is more complex but is an essential basis for planning the replacement and expansion of equipment used for the programme.

1.2. Since the last TECHNET meeting, progress has been made towards standard inventory and stock control software. This paper reviews this progress and offers for discussion our view of future strategy in this field.

2.0 Status of 'SLM' and 'CLM' stock control software

2.1. The Stocks and Logistics Module (SLM), developed by REACH, was described and discussed at the last meeting of Technet. This module continued to be used in Papua New Guinea and their experience has been described separately in Part I, Summary of Discussions. The module was also evaluated by CDC staff in the CCCD project in Nigeria who reached the same conclusion as ourselves; that while the functions of the programme were good, the Foxbase application itself needed to be re-written. Thus, CLM is a re-write in Clipper 5.0, by Management Sciences for Health (MSH), of the original SLM with faster smoother operation, a better user interface and much more flexible reporting facilities.

2.2. CLM has begun to be used in Nigeria and has also been briefly evaluated in Thailand. While being generally satisfactory, a number of improvements have been called from MSH in order for Thailand to evaluate the software fully, in routine use. UNICEF, Ethiopia is also evaluating CLM and both countries aim to

incorporate the software in the management of completely new central store facilities which will be opened this spring.

3.0 Status of "Impact" inventory management software

3.1. Impact version 2.2 was presented at the October 1992 EPI Research and Development meeting in Jakarta. The main strength of the software is that it lists, and costs, the new refrigeration equipment required by stores according to a variety of policy and programme performance changes. At present, the main weakness is that IMPACT only handles refrigeration equipment, not all EPI equipment.

3.2. IMPACT is in the process of installation and evaluation in Thailand and Ethiopia. An inventory had already been established in Ethiopia through a district-based census of equipment in all health units which was reported at the last Technet meeting. This data was transferred to IMPACT and data on the BCG immunization workload and coverage information were added to enable IMPACT to compare vaccine volume with equipment capacity.

Thailand has entered data for a single province. An existing, manually recorded inventory of equipment was used for this data entry, but a full census is needed to update the inventory before the results can be relied on. This is under way and it is anticipated that all provinces in this zone, covering a population of about 6 million, will also participate in building inventories for IMPACT during 1993.

3.3. Neither Thailand nor Bangladesh have significant shortages of equipment in the areas covered by IMPACT data; indeed, dramatic surpluses of storage space for vaccines exist in health centres in both countries. In Thailand, neither policy changes nor immunization performance increases appear to affect the Ubon province where vaccine is only kept for a short time at each level of the distribution process and where immunization coverage is in the 90s. In Ethiopia, immunization coverage is so low that refrigeration capacity far exceeds current needs.

3.4. However, the age of equipment is a critical factor in Thailand where the average age of refrigeration equipment in health units is 11 years. A number of improvements in the reporting and in

navigating within the cold chain are needed to make IMPACT more useful and easier to use.

4.0 Plans for further development

4.1. In parallel with the country evaluations of CLM and IMPACT software which are described above and which will continue through 1993, preparations are being made to ensure that these tools can be integrated with generic CEIS (EPI information system) at national and sub-national levels. This will involve some extension of the capabilities of CLM and re-programming for IMPACT in order to:

- extend the capability of CLM to provide for a multi- level, multi-store inventory of all EPI equipment, but maintain the possibility to use CLM as a simple stock control program for a single store.
- re-write IMPACT as a separate forecasting module, drawing from the equipment data maintained within CLM and from the immunization performance data contained within CEIS,

4.2. The reason for this re-arranging of the functions of CLM and IMPACT is that the data entry, modification and reporting of stocks and distribution of vaccines, supplies and equipment is a routine daily, weekly or monthly operation of EPI management. This is the strength of CLM. On the other hand, forecasting needs for major or minor equipment for long range planning is a periodic activity which only needs the power of the IMPACT forecasting capabilities relatively infrequently.

4.3. Equipment inventory data, particularly individual data on major pieces of equipment, and immunization performance data are most easily collected and entered at sub-national level. Thus, CLM and CEIS will have the capability to be updated by files received from 'lower-level' databases, which are being maintained at lower levels of the system. Those files can be received by diskette transfer, or transmission by telephone line.

4.4. Members and participants are welcome to evaluate both CLM and IMPACT software themselves and provide feedback to the secretariat. Diskettes are available on request[11], both for CLM and for IMPACT software. Please state what size and format you require.

[11] From Technet Secretariat, WHO/EPI/Geneva.

COLD CHAIN SURVEYS: BUILDING SUSTAINABILITY IN THE AMERICAS

Author: Peter Carrasco, AMRO/EPI, Washington

1. In 1988, the Bolivian Ministry of Health requested that PAHO assist them in identifying equipment needs for expanding their cold chain, as well as replacing equipment that had outlived its usefulness. Furthermore, without the proper justification for the selection of cold chain equipment, a concerned donor agency would not consider Ministry requests for assistance in procuring said equipment.

2. To assist the Ministry of Health in this effort PAHO developed a cold chain survey methodology that would permit not only the ministries to identify what existed and what was needed, but also to cost out the recurrent costs associated with the maintenance and repair of the cold chain. In addition, costs were estimated for the per diem and transportation associated with the vaccination efforts in areas of difficult access only.

3. The reason for this precise costing is that PAHO believes that , unless the allocation of recurrent budgets to rural health centres is made on the basis of actual, operational costs, even the best cold chain equipment will not guarantee success.

4. Between 1988 and 1992 PAHO, with the collaboration of the respective ministries of health, carried out cold chain surveys in nine additional countries: Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama and Peru. In each country the cold chain survey had the following objectives:

- to identify the type and condition of each type of equipment being used in the cold chain;
- to determine new equipment needs for the cold chain;
- to identify the recurrent costs associated with maintenance of the cold chain, i.e. fuel, spare parts, repairs supervision, distribution costs associated with vaccine and fuels, and per diem and

transportation cost for vaccinating the rural areas or the last links of the cold chain;

- to determine the quality of the procedures and operations of the cold chain;
- preparation of a Plan of Action with a summary of the major points identified during the survey and a proposal for activities for immediate implementation.

5. The outcome of these surveys has been:

- Identification of the total capital costs for equipment needs.
- Procurement of all, or part, of the equipment needs on the part of donor agencies in the majority of the countries where the survey was undertaken.
- Quality information for improving the management of the cold chain.
- Budgetary information on recurrent costs that can be used in budget planning in order to secure the necessary funds.
- Identification of cold chain training requirements for health center staff.
- Provision to other health programs of base line data on each health center (i.e. the location and the population served) for use in planning their activities.

6. In the Region of the Americas, countries that have previously carried out these surveys are now using these surveys to improve decision making regarding the types of equipment that need to be replaced and/or procured. The information provided on spare parts from the survey has been useful for managing and ordering stocks. Some countries are using the survey data to better plan their logistics.

7. However, the effect of these cold chain surveys on improving the overall management of the cold chain has been much less clear. It is not well documented that the cold chain surveys have led to an increase in recurrent cost funding for the maintenance of the cold chain. Furthermore, while vaccine coverage rates with the different EPI antigens have increased incrementally since 1988 in the Region, it is not clear that the countries have used the costing data provided by the cold chain survey to vaccinate the population served by the most difficult links of the cold chain.

8. Despite the limited data available on the impact of the surveys in the different countries, one fact stands out clearly that the surveys have provided estimated costing data on what is the minimum budget necessary to support the logistical operations and energy

requirements of the cold chain. This information, if properly managed, can become a powerful tool for the program manager. Furthermore, it provides a manager with a tool for monitoring expenditures and therefore, provides costing trends to help prepare budgets in the future.

9. If there is a scarcity of resources the manager can use the data to select areas of high risk and, therefore, target the available resources more prudently. Some argument has been given that many countries have no managerial tools for budgeting EPI recurrent costs and have doubted the utility of such costing data at different levels of management within the program. This author argues that one of the best tools that can be given to any manager at any level are costing data that can be used the measure the impact of his/her decisions, as well as, to defend his program against budget cuts to obtain a bigger slice of the pie.

10. In addition, such costing data can provide a very cogent argument to donor agencies regarding the commitment of the ministry of health to support capital investments made by a donor agency. (This assumes that the MOH can absorb the recurrent cost associated with a donation of equipment.) In short, the cold chain surveys, which not only capture information on equipment but also obtain recurrent cost data, will build a platform from which the investments being made today can be supported and sustained into the future. This in turn can stimulate new investments because a country can demonstrate the costs associated with a highly successful program such as EPI.

11. In many countries the EPI enjoyed a very bountiful decade during the eighties, with many countries receiving millions of dollars in aid and a good portion of that aid being invested in the cold chain. It is evident from the first three years of this decade (the 90s) that donor and national funding for the EPI will not be at the same level as that of the previous decade. In order to build up the argument for continued funding, this author argues that costing data is absolutely necessary to provide the manager with the tools necessary to sustain the achievements made to date.

12. If the argument made here is valid, the questions arise as to what elements of costing data are most relevant and how they should be collected during the cold chain inventory or survey. Since the cold chain is universal in its structure, the next question is: what is the method by which selected data should be collected, assembled, and analyzed? To be more explicit, what are the most important data on each type of equipment used in the cold chain?

13. The Technet members should strongly consider the proposal to standardize the cold chain surveys and the data being collected. This author believes that WHO should standardize its approach to carrying out cold chain surveys, much in the same way that other EPI information requirements are being collected globally in a uniform manner.

IMMUNIZATION CARDS SOLD TO PAY FOR THE EPI: SENEGAL

Author: M. Schlumberger, APMP, Paris

1.0 Present situation

1.1. The Bamako Initiative (BI) was conceived to enable the community to contribute to the cost of Primary Health Care (PHC). As a part of PHC, the Expanded Programme on Immunization (EPI) should also be partly supported by money collected from the community.

1.2. In West Africa, immunization cards are provided at a fixed charge of between 25 F CFA(US$ 0.08) to 100 F CFA (US$ 0.3). The Ministry of Health (MOH) pays 5 F CFA (US$ 0.01) to produce them, which represents a benefit to the health service of at least 20 CFA per card supplied. This enables the MOH to provide vaccines and to pay for other services not assisted by donors, such as yellow fever immunization and the activities of mobile teams.

1.3. Other documents also delivered to mothers are:

- 3 sheet, UNICEF-type cards (with nutritional chart and the "road to health") for mothers following Young Child Clinics (YCC).
- More sophisticated documents "health notebooks" (Approximate cost: US$ 1.00) where records, such as the prenatal visits of mother or assessments of physical and mental development, can be incorporated.

1.4. Strong polyethylene protective envelopes are sold for 5 F CFA (US$ 0.01) to increase life-time of documents. Even without these envelopes, the cards are kept by people very carefully (in Burkina-Faso, the retention rate was 50 %)

2.0 Project

2.1. In Senegal a system has been installed in Dakar to collect enough money to cover all the costs of immunization. Here, (200 F CFA,

0,66 US$) is charged for each card issued to the adult population, both men and women who receive single doses of vaccine (IMMULE) by injector costing 50 F CFA/Dose.

Card retention rates in Senegal have been surveyed during mass TT immunization and found to be about 25%.
Enough money is collected by the sale of cards to cover:

- cost of vaccines (50 F CFA/IMMULE tetanus toxoid dose)
- cost of delivery in mass immunization context or day-to-day immunization sessions.

INDIGENOUS EQUIPMENT MANUFACTURE

Author: A. L. Bhuyan, Unicef, New Delhi

1.0 Preliminary investigations

Before encouraging local production of equipment, a number of areas must be considered, as outlined below.

1.1 Identify a product for manufacture, then assess the following:

- immediate and recurring (yearly) project requirement of the equipment;
- production technology, process and machineries required for manufacturing the equipment;
- requirement of raw materials for production of the equipment;
- availability of the raw materials required and related import policy, if necessary;
- appropriate technology for production of such equipment and ascertain if similar/other products involving the same manufacturing process are available.

1.2 Check existing manufacturing policies: Examine local government's industrial development policy for product development and indegenization and any subsidy and/or support available for manufacturers.

1.3. Identify potential manufacturer/s interested and willing to develop the product even if production is limited to meeting project requirements only.

Assess the manufacturer's:

- range of products being manufactured using technology/manufacturing processes similar to those required for the equipment in question;
- machinery available and being operated for manufacture and/or mass production;
- production capacity of each product being manufactured currently;

- quality control practice/quality assurance measures undertaken ;
- research and development facilities ;
- type and amount of raw material, spare parts/components held in stock;
- current range of production;
- availability of technical personnel and manpower;
- experience in production line;
- financial position to undertake development of any new product and to set up a separate production line, if necessary.

Also check:

- if the manufacturer is involved with any ancillary producers and, if yes, check the standing of other producers;

- **if the manufacturer's current range of products are produced according to any standard specifications; and if manufacturer has the capacity to produce according to WHO/Unicef specifications.**

1.4 Costing

- Assess the inputs, including laboratory testing, that may be required for the product development process in terms of cost.

- Ascertain approximate price of the developed equipment (considering all exemptions, concessions that may be available) and check if it is competitive for the global market.

- Study the cost and time that may be involved in the development process, its cost effectiveness against the project requirement and the scope for export.

INDIAN MAINTENANCE PLANNING

Author: A. L. Bhuyan, Unicef, India

1.0 Background

1.1. With universalization of the immunization programme, 125 walk-in-coolers and freezers, about 13,000 ILRs, 11,000 Chest Freezers and 20,000 voltage stabilizers were provided within 5 years to the 447 Districts of 32 States and Union Territories of India. These quantities increased to 128, 15000, 13000, 25000 respectively by end 1992.

1.2. Considering the volume of the work against the preparedness of the states and allowing the required time to build up internal maintenance capacity, Unicef extended maintenance support up to 31 March 1991, continuing the service of the agents beyond the warrantee periods.

1.3 One post each for Cold Chain Officer (Engineer) and one post for refrigerator mechanic for each district were sanctioned by the Government of India. Training of refrigerator mechanics was started from 1984. With increase of appointment of mechanics, the number of courses per year was increased accordingly. Complete refrigerator repair tool kits were provided to each district and spares made available.

1.4. Though the states had taken over the responsibility, it was observed that most of them had developed their maintenance systems on an ad-hoc basis. Some of them were not comprehensive enough to cover all the requirements. Observing the above, the Government of India and Unicef planned a series of 2-day Review Meetings-cum-workshops to review the existing system in each State and to assess its strengths and weaknesses in order to assist the states in finalising the Plan of Operation of the Maintenance system, and to find solutions to problems, if any.

2.0 Objectives

Overall objectives:

To review and finalise a Maintenance Plan for the Cold Chain and other equipment such that :

- at any point of time, not more than 2 to 3% of the cold chain equipment (ILR/Deep Freezers) remain out of service; and all WICs are functional.
- break-down is attended and minor repairs carried out within 3 days and major repairs within 7 days;
- adequate quantities of spare parts and float assemblies are available at different levels at any point in time.

Specific objectives

- To review the existing maintenance system, assess the strengths and weaknesses and develop a sound maintenance plan for the state;
- To establish effective state/region/district infrastructure;
- To strengthen the workshops with storage space, tools and instruments for more effective and efficient maintenance;
- To establish an effective management system to ensure availability of spares, consumables and float-assemblies at all required levels;
- To develop and establish an effective reporting and monitoring system to provide information to the state on the status of cold chain equipment and to cater to the needs of various regions/units.
- To develop a plan for timely replacement of equipment which is un-repairable and aging, and;
- To develop a plan to meet vaccine storage needs under emergency situations.

3.0 Methodology

Conduct plenary sessions to introduce the background of the maintenance system currently followed in the state and outline the requirements of a sound maintenance system;

Present various components of the existing maintenance system, followed by group discussions.

Conduct a valedictory session to present the final Action Plan with time-frame for submission to the Government for approval.

4.0 Participants (35-40):

Commissioner/Secretary (Health);
Director/Addl.director (FW);
Official/s from Government of India;
Concerned UNICEF Staff members from Country & Field office;
State EPI officer;
State Cold-chain officer;
Up to five Regional officers (FW/MCH) and District Immunization Officers;
Head of the State Health Transport/Health Equipment;
Repair Organization (if any);
Engineers of SHTO/HERO (if any);
Technicians engaged in maintenance works;
and any other officials related to maintenance works and either playing or to play an important role

4.1. The requirement and availability of the resources are examined against each important component required for maintenance. A 'short-term' plan with existing resources is prepared for immediate implementation. An ideal 'long-term' plan is prepared for the near future. Both the plans are integrated, indicating phased implementation within a time frame, starting with the short-term plan and arriving at the long-term plan. Actions necessary and decisions to be taken are clearly identified/defined, indicating officials responsible and time-schedule.

5.0 Components identified

5.1 Manpower

- Availability
- Work distribution
- Management
- System approach
- People - 'the team'
- Where district mechanics are available (50% or more)
- Ideal, available and additional manpower requirement, planning recruitment;
- Available mechanics pooled to regional centres and reorganized according to work load proportion,
- Ideal maintenance plan and time-schedule for phased implementation.

Where no/only a few district mechanics are available:

- Areas that can be covered by the existing staff;
- Potential contractors and coverage they can provide;
- Entrusting works to contractor/s, excluding departmental coverage, period of contract;
- Ideal maintenance plan and time-schedule for phased implementation.

5.2 Establishment of repair centres and work-load distribution

Examine :
Regional vs.District >< decentralization vs. cost
Mobility/transport/time)

- *Identify functions*
  - Administrative
  - Repair
  - Training
  - Inventory
  - Information
- *At levels*
  - State
  - Regional
  - District
  - PHC
- *Ascertain for each repair centre:*
  - Location
  - Accommodation
  - Geographical area to be covered
  - Type and number of equipment to be attended

5.3 Training

- Status and need
- How many in which course
- When

Training courses available :

- WIC - Electrical system
- WIC - Refrigeration system & Generator
- ILR/Freezer repair
- Spare parts management training (planned)

5.4 Tools, instruments and equipment for

- Repair
- Storage
- Inventory control & management

Assess ideal, existing & additional requirement

5.5 Spares, consumable, float-assemblies and their management

What? How many? Where? When? System for management?

Ascertain :

- Maximum levels required at each point of storage;
- Total state requirement, stock in hand & additional requirement;
- Storage space and equipment need;
- Training needs

5.6 Transport

Examine use of :

- Available Bus/Train services; available vehicles; two-wheelers.
- Additional transport requirements.

5.7 Reporting and monitoring system

Reporting for:

- Base-line data
- Detail inventory of equipment

Planning for:

- Requirements/actions
- At which level
- How many/what
- When

Monitoring:

- Equipment/spares/repair status
- Response/down time

Fault analysis

- Preventive/remedial measures
- Spares forecast

Develop most suitable, efficient & prompt information and response system reducing each time sector below :

Breakdown	Report sent	Report received	Tech. deputed	Repair complete	Response time	Down time

5.8 Manpower deployment system

Finalize :

- Authority for deployment of technicians at each level;
- Deployment/work-order system avoiding normal procedural delays,

5.9 IEC materials

- What
- How many
- When

Materials available :

- Hand-books for WIC Technicians, Voltage stabilizers repair, WIC Operators
- User's Manuals - ILR/Freezers
- Spare parts list and code guide
- Video modules - Cold Chain, 'Electrolux' IRL,'Vestfrost' ILR & Freezer
- UIP Supplies - item detail
- Instruction stickers

5.10 Phased replacement plan for over-aged equipment

- Old, un-repairable
- Beyond economic repair
- Internal leak

Life of equipment depends on factors like conditions of installation, maintenance, handling, environment, electricity etc.

The equipment are of different ages.
All equipment installed in same year may not need replacement at the same time. Replacement actions may have to be spread over a period of several years.

Survey to assess condition to find common norm for phased replacement of aged equipment.

Immediate replacement of equipment beyond repair due to internal leak.

5.11 Proper Power Supply to Equipment:

Rectification of power supply wiring where temporary/ hazardous/under-rated/defective.

5.12 Budget:

- Pay/TA/DA of staff;
- Maintenance cost (if contracted out);
- Spares and Consumable;
- POL/Maintenance of vehicles;
- Contingency

5.13 **Contingency plan for emergency situation:**
Two alternative storage against each WICs and related arrangements;

- For commercial cold storage as alternative, authorization and approval for hire charges from appropriate authorities;
- Contingency plan for all vaccine storage points, listing out the resources, actions involved and training responsible persons.

6.0. The experience

6.1. A comprehensive plan, covering all major components, is arrived at;

6.2. Officers at all levels (non-technical, except the Cold-Chain Officer) involved in the maintenance process get a clear view of the situation and the requirements. This helps to identify the neglected areas which need their extra attention.

6.3. Higher officials of both Central and State Governments participate, many financial and administrative issues get sorted out and expedite the process of approval of the plan and its implementation.

TELE-COMMS FOR SURVEILLANCE

Author: John Lloyd, Technet Secretariat

1. This year, over 80% of the world's infants have been fully immunized and over 3 million deaths will have been averted. Having achieved this level of coverage and having ambitious goals of disease elimination and eradication for the 1990s, the EPI will depend more than ever on the systems of routine reporting. Only accurate and timely reporting of immunization coverage and disease incidence can provide managers with the picture of programme impact which is needed to meet these goals and keep the programme on the path of improvement.

2. It has been shown in the countries of Latin America that, when motivation is sufficient and when communications are reliable, accurate weekly reporting can be achieved from district to central level and even to international level also. Elsewhere in the world, even where sufficient staff motivation exists, the communications network is unreliable and data are lost. The prospect for accurate weekly or even monthly reporting in most of the world's developing countries seems distant.

3. However, several technological advances in recent years have improved the prospects for data recording, transmission, aggregation and feedback markedly. Firstly, the cost of computers have reduced dramatically while their data storing capacity and their reliability in adverse conditions has improved dramatically. Secondly, a revolution in telecommunications has taken place, enabling data to be sent with complete accuracy through poor and intermittent telephone lines using software and modem equipment widely available at low cost.

4. For under $US 1000 it is now feasible to use a small computer to collect data routinely and have that computer linked to a telephone line so that it automatically transfers files at a preset interval to a host computer installed at another level of the system. If the line is interrupted or the quality deteriorates seriously, the computer automatically calls again. Energy for small computers is

easily provided by small portable solar panels and this has been successfully tried by EPI staff.

5. For under $US 5000 it is now also feasible to install the same system where there are no telephone lines. The message is transmitted, like a telex, via short wave automatically at a preset time. The range of such a system is 2000 kms. And systems exist at about $US 2000 to transmit via VHF about 18 kms, say between a health centre and the district office. Again, solar energy would be best source to power this equipment.

6. Such systems of data collection can only succeed with a very simple interface between the user and the computer, as close to a sheet of paper as possible! One possibility is to adopt the principle of a 'spreadsheet' on which to enter data. Certain cells would be open for the user to enter data. Others would be 'frozen', only able to be reached or changed by an authorized supervisor. Some of the 'frozen' cells would contain labels or captions to show the user where to enter data, and other 'frozen' cells could contain formulas to enable accumulations to be calculated (immunization coverage for example) and presented permanently on the screen.

7. In this case the user would only need access to the numeric keypad and, possibly a switch to move from one speadsheet 'page' to another. This simple principle has already been the secret of the great success of spreadsheet software in the early years of the personal computer revolution.

8.0 Recommendations for discussion

8.1. Many countries would be ready to test the capability of a small computer to collect and transmit data automatically if the components of such a system were to be assembled and offered for trial.

8.2. WHO/ISS/EPI are close to agreement on the combination of software and equipment which would offer the highest performance and reliability at the least cost. Later in 1993, we will then be interested to test a small telephone-based installation, first on the bench and then in the field. News on the bench tests will appear in TECHNET publications later this year.

8.3. When field trials begin, they will be exploring capability of such a system to communicate data directly into the generic CEIS system of the EPI.

POLIO STOOL SPECIMEN COLLECTION: UPDATE

Author: John Lloyd, Technet Secretariat

1.0 Introduction

National and international laboratories are receiving an increasing number of polio stool specimens from the field and from hospitals and they are monitoring the condition of the specimens on arrival. This evidence and the reports of field visits suggest that some improvement is needed before most countries can claim to have an adequate 'reverse' cold chain for specimens. This is a summary of only some of the experience accumulated since the distribution of standardized specimen collection materials to countries investigating cases of flaccid paralysis. You will, we are sure, have plenty of experience and opinion to add. Please share this with us during the TECHNET conference.

2.0 Training and specimen collection

2.1. Specimens should be collected by a trained polio epidemiologist who is trained in case investigation of flaccid paralysis, including the logistics of specimen collection. In practice, while regional epidemiologists have received full training, the specimens seem to be most frequently collected by district health staff or hospitals. Specific training on specimen collection for polio eradication has not always reached these district staff, nor have hospitals been always included in national training exercises. Even if major hospitals were represented, the smaller hospitals were not. The consequences, seen in several countries, include:

- inadequate, incomplete specimen identification,
- inadequate containers used for stool collection,
- freezing and re-freezing of specimens during transport,
- incorrect use of the rectal tube,
- no cold chain to protect specimens at all.

2.2. **Action for discussion:** No training module exists on specimen collection, except the section in the red Polio Laboratory Manual

which is no longer completely up to date. WHO/EPI should create such a module as a matter of urgency.

Training in specimen collection should be integrated into routine refresher training for district staff and specific training should be organised for hospitals.

3.0 Identification of specimens

3.1. In spite of the existence of the EPID standard identification of cases of suspected Polio, this identification system does not seem to be widely adopted. The name, the address and the sample reference of the national laboratory is often the only reference for the case. One reason for this appears to be that the international version of the code, while including characters to identify the country, does not specifically recommend that additional characters should be given to the region. So the issue of a new sequence code for a new case must be obtained from the national level office which is not always a practical procedure.

3.2. In Pakistan, where most virus isolation is carried out in a national laboratory, they propose to substitute the national three letter code, 'PAK' with a provincial one-letter code, thus enabling the provincial office to issue new sequence codes i.e.: P93001 now indicates the first case in sequence to be investigated in 1993 in Punjab province.

3.3. **Action for discussion:** An EPID code to identify each case investigation in a unique and reliable way is essential in every country. However, the EPID code should contain characters to identify the geographical region within which IT IS PRACTICAL TO ISSUE NEW SEQUENCE CODES.

4.0 Use of the rectal tube

4.1. References on the experience to date with the rectal tube technique for specimen collection include:

- PAHO Newsletter - February 1992
- TECHNET Newsletter - August 1992
- EPI-TECHOM Meeting report 1992

4.2. In spite of the convenience of the technique, the value of a 'supervised' specimen and good rates of virus isolation from specimens collected in rectal tubes, they usually used only if

collection cannot be made in a conventional pot. The main problem has been that, when the stool is hard, it is nearly impossible to collect. Repeated insertion of the tube to try again and again to collect is potentially damaging to the walls of the rectum.

4.3. Non verbal instructions packed with the rectal tubes have been changed. They now show the child placed in the SUPINE position (instead of lying face downwards) and the legs folded forward over the chest to expose the rectum. Other instructions also warn that the tube should not be inserted more than twice in an effort to collect stool before this technique is abandoned for that child. Finally, in the future, rectal tubes will not be packed with a transport medium as they are at present, as the advantages of the medium were outweighed by problems of colour change in the pH indicator and cost of assembly.

4.4. **Action for discussion:** If the rectal tubes are being distributed in your country, the new information and instructions should be given to all those responsible for specimen collection.

Further experience and feedback is always needed on the use of the rectal tubes in the field. A decision must eventually be made as to whether the tubes should be included in the standard collection kit or whether they should be made available as a separate stock item. Ideas and views please!

5.0 Local manufacture of kits

5.1. Pakistan is in the process of seeking local suppliers for the following version of the specimen collection kit - without the rectal tube - but including the 3M indicator (48I) which will be imported. The cost of the 48I indicator is 2.20 SF, minimum order 500, from 3M, Switzerland:

- Specimen collection form (See standard WHO sample) in polythene bag (Ziplock if possible)
- Two stool specimen containers, Gamma sterilized Polypropylene, Minimum height 50 mm, Minimum diameter 34mm External screw cap with airtight seal but no sealing ring; internal spatula 8-10 mm wide projecting from inner lid surface towards base of the container
- Absorbent cotton wool pad Weight: 2 gms, Size: 90 x 160 mm
- Temperature indicator 3M Cold Chain Monitor (48I)
- Polythene bag large enough to contain kit (Ziplock if possible)

- Labels Waterproof adhesive, 80 x 40 mm
- Instruction sheet in local language (See standard WHO sample)

6.0 Carriers and icepacks

6.1. The 'FREE' supply of special Australian specimen carriers is exhausted and some countries have begun to search for supplies through UNICEF. More often, however, standard vaccine carriers are being used to collect specimens. Standard vaccine carriers do not always have sufficient cold life to carry the specimen from the point of collection to the laboratory without an exchange of icepacks or storage in a refrigerator.

6.2. In the countries, a variety of risks are being taken including storing specimens in vaccine freezers and exchanging icepacks for polio stool specimens with those used for vaccines. There is a danger that wild polio virus, which can contaminate carriers and icepacks used to transport stool specimens, may also contaminate vaccines if the same materials are used both for stool collection and for vaccine distribution.

6.3. Where specimens must be sent be shipped by air within the country, the cost of the shipment is too high to send each specimen independently. Specimens are accumulated over several days to make an economic shipment. This has entailed that specimens are stored, in the case of Pakistan, in a freezer.

6.4. **Action for discussion:** ALL vaccine carriers and ALL icepacks used for the Polio reverse cold chain should be marked indelibly 'FOR POLIO STOOL SPECIMENS ONLY' and should never again be used for vaccines. If it is necessary to introduce unmarked frozen icepacks to replace the marked ones during a journey to the lab, they should then be marked and used only for polio.

Polio stool specimens should only be frozen when it is guaranteed that they will remain frozen. This is usually only when they reach the national laboratory or the central store. At lower levels, where it is necessary to store specimens during stages of transport, a refrigerator should be DEDICATED to Polio stool specimen storage.

7.0 Laboratory monitoring

7.1. When the reverse cold chain is first established and specimens start to flow to the national laboratory, experience shows that the

standard of collection and transmission of specimens varies from region to region. In order to pinpoint where there are problems and what kind of problem exists, it is recommended that the arrival of specimens in the laboratory should be closely monitored, at least for the first six months and until a few of specimens have been received from each district. The following parameters are the most important to monitor and analyse:

- are the specimens submitted in the standard collection kits?
- what is the 3M Monitor index on arrival at the laboratory?
- are the specimens submitted in pots or tubes?
- if tubes, is the quantity of specimen sufficient for virus isolation?
- has the pot/tube leaked?
- is the identification and origin of the specimen clear on the labels?
- is the EPID identification code applied correctly?
- dates of:
  - onset of paralysis
  - collection of specimens 1 and 2
  - despatch of specimens to the laboratory
  - receipt of specimens by laboratory
  - report provided by the laboratory

7.2. **Action for discussion:** Polio programme managers should demand that such monitoring is carried out so that they can identify areas requiring additional training.

TRANSPORT POLICY, A PERSONAL VIEW

Author: Lionel Pierre, Short Term Consultant, Côte d'Ivoire

1. What do you believe to be the most important tool for the management of a national vehicle fleet?

n inventory system. It is essential to: forecast vehicle replacement; monitor running costs; and monitor vehicle utilization and maintenance

Very simple inventory systems allow easy control through routine monthly reporting.

2. Is it really realistic to demand regular preventive maintenance?

t is never easy to lose the use of a vehicle for a day but, if vehicle maintenance is scheduled in advance to fit in with other activities, it is not an impossible demand. On the other hand, it is absolutely uneconomical to run a vehicle without maintaining it because the subsequent breakdowns cost so much more.

3. What is the best advice you can offer on using vehicles more efficiently?

Managers must keep control over how they are used. the best known control systems for managing commercial fleets worldwide use "route plans" and systematically process the information contained in logsheets.

4. How necessary is it to retrain motorcycle riders and vehicle drivers?

Accident rates are lower for riders and drivers who have received thorough training in riding and driving techniques. Public driving tests rarely achieve adequate standards of preventive maintenance, fault- finding, emergency vehicle recovery and first aid.

5. Why do you attach so much importance to vehicle replacement policies?

A young fleet is a more efficient fleet. In order to balance running and maintenance costs against resale value, a cut-off point must be established for fleet renewal. Light trucks, automobiles and motorcycles generally have a depreciation rate of 20 to 25 % a year in market value. After 4 or 5 years of operation, these vehicles are considered amortized.

Preventive maintenance during this interval will cost an average of 30 to 35 % of the equipment's original value (or 6% a year). Past that period, repair costs tend to rise for the vehicles while their market value (and reliability) decrease. This is the time when proceeds from sales of the vehicles can still be substantial enough to be used against procurement of new vehicles or as Government contribution to the maintenance of the replacement fleet.

6. Can vehicle sales or motorcycle ownership agreements help to motivate personnel?

Yes. I have seen several countries where operators of ministry of health transport equipment provide better care for their units when given first refusal on sales of vehicles or when ownership is transferred to them after a preset utilization period (see article on motorcycle user agreements in Newsletter, March 1992).

7. What about vehicles which cannot be repaired nor sold?

In order to avoid rapid depreciation or total loss, vehicles should not be left incapacitated for more than one six month period. A vehicle which for any reason cannot be repaired or sold after this

period should be broken (scrapped) and the salvaged components used for repair work or sold to credit the vehicle maintenance account.

8. Now it's your turn, Technet Conference participants! What do you see to be the most practical solutions to the problems which you have seen and why?

RIDERS FOR HEALTH: UPDATE FROM SAVE THE CHILDREN FUND

Author: Andrew Timpson, Save the Children, UK

1. Save the Children Fund/Riders for Health now have motorcycle projects operating in eight countries in Africa. Most of them are concerned with getting health workers safely and efficiently into the field, but we are also working with social workers (Uganda), water engineers (Malawi) and best practice/food security monitors (Mali). The health projects (primary health, disease control and immunization) are in the Gambia, Ghana, Burkina Faso, Malawi, Zimbabwe and Lesotho.

2. Since we started working on the Riders for Health project early in 1989, what we have chiefly learned is not to trust our assumptions. For example, when we started to think about how motorcycles might be used effectively in development we assumed the key was training. This was natural. The motorcycle is a fairly complicated piece of equipment and can be dangerous. An untrained rider is obviously a danger to him or herself and everybody else.

3. But we were missing the point. The evidence was there to see (though we missed its importance) during our first exploratory mission to the Gambia. It was this. We (representatives of SCF and Transaid) were told that motorcycles were operating in each of the Gambia's three administrative regions. In the western region we saw no motorcycles though we did hear that some were operating. In the central region we saw none at all but in the eastern region there were indeed 12 aging machines running.

4. But why? What was the difference? The answer was that an SCF driver, Ali Ceesay, was using what would otherwise be wasted time during monthly training meeting by fiddling with their motorcycles. Ali wasn't trained in mechanical matters, but his common sense was having a very good effect on the motorcycles.

5. The point we missed at first was this: the eastern region bikes had the benefit of what amounted to a very basic management system. Once a month those motorcycles were worked on whether they 'needed' work or not. It was a routine.

6. Using Ali and a number of mechanics from the Ministry of Health's transport depot at Kanefing, we piloted a training system which is used in all eight countries today. Naturally it has evolved a little, but it is essentially the same.

7. First of all, of course, we train trainers. The trainers have the basics of riding and ideally should be experienced motorcyclists. They undergo a four-day course that concentrates on off-road riding skills (uphill, downhill, through sand, mud, water, rocks etc.), road safety and maintenance. Maintenance is based on a simple and unforgettable mnemonic: PLANS (CHEFS in French), which reminds riders of their obligatory daily maintenance routine: P is for petrol (make sure there is enough); L is for lubrication (for the engine, but also the chain); A is for adjustment --chain and handlebar levers; N is for nuts and bolts -- are they tight? and S is for stop -- test the brakes and check the tyres.

8. Once the trainee trainers have completed their four-day course, they take other riders through precisely the same process. Each trainer teaches four or five riders. So far, so good.

9. But it turns out not to be good enough. Training, though vital, is only one component of any successful programme. The eight countries (and nine programmes) in which SCF/Riders for Health is involved tell us a clear and conclusive story: the more fundamentally we are able to influence the management of the project, the more successful it will be. To put it another way, management is the key.

10. Our most successful project (so far) is in Lesotho, where the earlier history of motorcycle use enable us to become very closely involved with the ministry of health. In turn the ministry have developed a highly expert understanding of what kind of commitment is demanded by a successful motorcycle fleet.

11. Several attempts had been made to use motorcycles. It is not clear what training took place but most certainly the level of maintenance was very poor and there had been several accidents. Most of the donated bikes were off the roads when the SCF/RFH project began in 1990.

12. The brief history of the project is this. Firstly we agreed with the ministry that if they were able to appoint a local fleet manager, we would send an expert fleet advisor to work alongside him/her. This was agreed and done. Secondly, we agreed to address five pilot health service areas so that we did not attempt too standard Riders for Health training programme. We used a highly skilled instructor from the UK who trained five trainers and the fleet advisor.

13. Management regime was put into place that demanded daily PLANS maintenance and a monthly service to be carried out by the fleet manager and fleet advisor. All maintenance is preventive. Parts are replaced on a strict schedule and a breakdown is regarded as a failure. Initially there were 12 machines in the field but now there are 27. Since the programme officially began in September 1991, we have not experienced so much as a single breakdown. So far, this is a zero-breakdown fleet.

14. There are a number of other factors that enable this to happen. Firstly, SCF's own management is highly committed and the field director stays closely in touch with the programme. Secondly, we chose the correct machine for the task (very often, projects are equipped with inappropriate bikes) -- in this case a Kawasaki KV 175 agricultural specification machine. Thirdly we had excellent support from the importers, Kawasaki in South Africa. Fourth, the project has excellent personnel.

15. The Lesotho programme is now run entirely by Mohale Moshoeshoe, the fleet manager. And since the mechanical aspects of the fleet are now understood and running well, Mohale (a health worker by profession) is now able to turn his attention to the more pressing question of how to make personal mobility truly effective in delivering health services.

16. Throughout Africa, Riders for Health programmes are now delivering services where none was delivered before. Certainly, the riders are well-trained . But the only way to make sure their training is not made useless by a defective motorcycle is to set it firmly in the context of disciplined, repetitive management.

17. We have published a set of management guidelines and a one-year evaluation of the Lesotho programme. They are both available from SCF (UK) on 44 1 703 5400. Ask for Gilly Usborne in the overseas department.

= = =