Appropriate Health Technologies: Concepts, Criteria, and Uses

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Learning objectives

1. Describe the evolving concept of appropriate health technology
2. Describe the potential impact of appropriate technology on the health of people around the world
3. Understand the appropriate technology development process
4. Clarify the criteria for designing appropriate health technologies
5. Discuss the complexities of introducing appropriate health technologies
6. Recognize the role of collaborations in facilitating development and introduction of appropriate technologies

This module will discuss the role of Appropriate Health Technology in the context of global health. Starting with definitions and current concepts of appropriate technology, we will proceed to take a deeper look at how appropriate technology is developed and introduced. We will conclude with several case studies illustrating the development of appropriate health technologies.
- Definitions -
Origins of Appropriate Technology (AT)


- Schumacher: “Intermediate Technology”

- Term is used in two primary contexts:
  - technology that most effectively meets peoples’ needs in developing or limited resource settings
  - technology that is environmentally and socially acceptable in the developed world

Image retrieved from:
www.flickr.com/photos/74233090@N00/1463622804/
Notes to Origins of Appropriate Technology

• The concept of appropriate health technology envisioned in the Alma-Ata Declaration reflected the influence of E.F. (Fritz) Schumacher’s ground-breaking 1973 book "Small is Beautiful - Economics as if people mattered". At a time of increasing environmental consciousness and the first energy crisis, Schumacher proposed a vision of human-scale technology that takes into account the economic, cultural, social and environmental needs of the communities and individuals it is designed to serve. What Schumacher coined “intermediate technology” sought to address the economic disparities suffered by developing nations by emphasizing distributed, labor-intensive solutions over centralized capital intensive approaches. It was soon recognized that Schumacher’s approaches for reducing economic disparities might be equally applicable towards addressing health disparities.
Intermediate Technology

“Intermediate”: between artisanal and industrial.
  – Simple
  – Effective
  – Cheap
  – Environmentally sound
  – Sustainable

• Emphasis on local community ownership, management and maintenance.

Schumacher used the term “intermediate technology” to describe solutions that are neither fully indigenous or artisan, nor industrial. The Kickstart treadle pump shown here is a classic example of appropriate technology, and represents an intermediate solution between hand-watering crops and community-scale infrastructure.
Evolving Definitions: Alma Ata Declaration (1978)

“Primary health care is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination.”

http://www.who.int/hpr/NPH/docs/declaration_almaata.pdf
Notes to Evolving Definitions, Alma Ata

• The Alma-Ata Declaration of 1978 was the first international statement emphasizing the importance of primary health care in reducing global health disparities. The Declaration defined primary health care as a collaborative effort involving all participants in the health system, from individuals and communities, to health providers, to national health services. The Alma-Ata declaration reaffirmed health as a fundamental human right, and set a target of bringing “Health for All by the Year 2000”.

• Within the Declaration, paragraph VI outlined the attributes of what would later become known as “appropriate health technology”. Reductions in global health disparities would be supported by practical, effective and socially acceptable technologies that are accessible, affordable by community and national health systems, encourage self-reliance, and result from participatory processes.
Result: Appropriate Health Technologies (AHT)*

- Methods, Procedures, Techniques and Equipment that are:
  - Scientifically valid
  - Adapted to local needs
  - Acceptable to users and recipients
  - Maintainable with local resources

*as defined by WHO (December 1989)
Notes to Result: AHT

- The basic definition of appropriate health technology has remained valid since it was proposed in Alma-Ata. However it was evident that health technologies developed for developed world conditions were inappropriate for use in resource-poor environments lacking physical infrastructure, trained health providers, or the means to buy and maintain complicated technologies. Where appropriate technologies (such as ORS or contraceptives) existed, they faced significant obstacles to widespread adoption.

- Appropriate health technologies are defined by a pragmatic interpretation of Schumacher’s criteria. They are new technologies or adaptations of existing technologies of demonstrable effectiveness that can sustainably meet the varied conditions of developing countries and the unique needs of underserved communities. Schumacher’s emphasis on social control shifts to an emphasis on effectiveness and public health impact when considering appropriate health technologies. There is not necessarily a correlation between scale, complexity and expense. Scale can imply simple and cheap as much as small can be complex and expensive. The most appropriate technologies may in fact require cutting-edge engineering and industrial-scale manufacturing to deliver the greatest simplicity, effectiveness and sustainability at the lowest cost.
“Hard” and “Soft” Technologies

• *Hard technology* employs engineering design, available materials and manufacturing equipment to bring about solutions that further self-reliance and determination.

• *Soft technology* brings about change by influencing individual and community decision-making behavior through social participation and action.

Appropriate technology is necessary but not sufficient to bring about widespread reductions in morbidity and mortality. Sustainable solutions depend on developing effective, low-cost technologies as well as developing the social structures, political will, and individual and group behavior change that make technologies accessible, acceptable, and responsive to a perceived need. The differentiation between “Hard” and “Soft” technologies was proposed by Maurice Albertson and his wife Audrey Faulkner, key architects of the Peace Corps.
- Determining Criteria and Needs -
Criteria for Appropriate Health Technologies

- **EFFECTIVE**, both in theory and in practical use
- **SAFE**, and not easy to use incorrectly
- **AFFORDABLE**, in initial and recurrent costs
- **ACCEPTABLE**, to all who are affected by it
- **SUSTAINABLE**, can be maintained, repaired and re-supplied

Appropriate health technologies can range from simple products that can be made at home (such as ORS) to highly sophisticated products (such as point-of-care immunodiagnostics) that require state-of-the-art manufacturing processes and materials. These criteria touch on aspects of both “hard” and “soft” technology as previously described. As Chris Elias, President and CEO of PATH puts it, “Solutions that creatively integrate the need for new and culturally relevant technologies with stronger systems and substantial behavior change have a chance of reducing the health inequity between rich and poor countries” [Essay: Can we ensure health is within reach for everyone? *The Lancet*, Volume 368, Issue null, Pages S40-S41 C. Elias]
Examples of the Need for AHT

- Vaccines exposed to heat lose their potency
- Cold chains designed to protect vaccines need expensive equipment, fuel and maintenance
- Syringes that are not properly sterilized or destroyed transmit disease
- Contraceptives have side effects and may be unacceptable to high-risk populations
- Rapid and accurate diagnostics for tropical diseases are unavailable where needed most

Some health technologies developed as “appropriate” for global settings later proved unacceptable by certain populations, or were found to have unintended consequences. For example, while ORS is highly effective at reducing infant mortality due to diarrhea, it may not be used when mothers realize it doesn’t “cure” diarrhea. The indiscriminate use of DDT, a highly effective vector control agent, resulted in both environmental damage and the emergence of resistant strains of mosquitoes.
Criteria for Defining Health Need

- Magnitude of affected population
- Level of morbidity and mortality caused by condition
- Lack of appropriate technologies

Appropriate technologies are designed to meet specific health needs. Criteria for choosing which needs should be addressed could include considerations such as the magnitude of the population affected, the degree of morbidity or mortality caused by the health condition, and the lack of solutions that are effective, safe, acceptable, affordable, accessible, and sustainable.

Health technologies taken for granted in the developed world are often inappropriate or inaccessible in the developing world. Additionally, the spectrum of diseases and health priorities in developing countries often differ from those in the developed world, requiring unique diagnostic, treatment and preventative approaches.
Who Defines Needs and Solutions?

- **Users**
  - End users affected by health condition
  - Health providers (public and private)

- **Stakeholder involvement and endorsement**
  - Engaging the public sector
  - Partnering with the private sector to advance market based solutions
  - Donors
Notes to Who Defines Needs & Solutions

- The development of appropriate health technologies for resource-poor settings is typically driven by perceived health need rather than market demand. Co-design strategies engaging end-users to help define technology solutions is a fundamental means to ensure that their needs will be met in appropriate, effective and culturally relevant ways. Appropriate solutions often emerge through “bottom-up” innovations from end-users, as much as from “top-down” strategies of producers.

- Needs assessment needs to be a collaborative effort between public sector health specialists, private sector organizations (for profit as well as not for profit) involved in technology dissemination and implementation, and end users. Public health technologies, in particular, depend on achieving consensus among public and private partners regarding perceived needs and solution approaches, as well as a shared understanding among partners of the processes of health technology development, evaluation, licensing, distribution and monitoring.

- In cases where a need has emerged due to market failure, public sector stakeholders need to determine what incentives are necessary to engage the private commercial sector in developing and fulfilling end-user demand. At times the participation of international agencies and regulatory bodies to endorse products or aggregate demand can provide the incentive needed to develop technologies that wouldn’t otherwise be pursued.
- Technology Development Process -
Making the Value Proposition

Objective:
Utilize a standard framework for initial evaluation of new technologies to design more efficient and effective programs:
– To highlight risks before the project is undertaken
– To better understand key areas of potential program focus
– To better understand the key elements of the value proposition by which to engage stakeholders

Methodology:
Assess technical, programmatic and market feasibility using inter-disciplinary tools and a “light” evaluation framework

At PATH we employ a process called RAVE to make early assessment of the value proposition for developing a new technology solution. RAVE stands for Rapid Assessment of Value Exercise.
RAVE Framework Elements

Technical Analysis
- Functional Gap
- Technology Risks
- Time to market

Program Analysis
- Acceptability
- Impact on system costs and benefits

Market Analysis
- Feasibility of creating supply
- Demand side market segments and risks

Program Design

Assessment

Assessment

Assessment

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Technology Selection

• Define function and users
• Specify essential and desirable attributes
• Identify all options
• Assess for effectiveness, acceptability, affordability, sustainability

Once you have characterized the need and determined the intended end-users, then you can consider candidate technologies. Is this a need for which a technology already exists? Does that technology need to be adapted to be made more appropriate for the delivery context or the intended users? Or do you need to innovate a new technology solution for which you will need to specify essential and desirable attributes?
Appropriate Technology: Part of a Healthcare Ecosystem

Technologies

People
- knowledge
- skills
- culture, beliefs

Infrastructure
- facilities, equipment
- communication systems
- financing
- policies
- regulations
Notes to Approp. Tech; Part of a Healthcare Ecosystem

- Technologies alone can not improve health. They can only have impact if they are incorporated into a comprehensive health delivery system. That system, whether in a limited resource setting or a fully industrialized country, will consist of infrastructure and the people (both providers and patients) that will come in contact with the technology. Appropriate health technologies need to be adapted to the human, physical and financial resources available in the environment where they will be used. Defining the attributes and characteristics of appropriate health technologies needs to take place early in the product development cycle to ensure that the technology is adapted to user needs, rather than users having to adapt to the technology.
Technology development and introduction

Appropriate technology development is one component of a broader set of activities that go into delivering a sustained health impact. Anticipating the steps involved at each stage of the development cycle, from innovation (R&D) through introduction (proof of concept and pilots) to integration (scale-up and evaluation) is critical for successful health technologies.
Pathway from technology selection to correct and effective use

- **Recommended "best" technology**
  - Not clear:
    - evidence not synthesized or disseminated
    - inadequate evidence
    - no adequate technology

- **Clear**
  - Used consistently
  - Not always used:
    - not available; poor quantity, distribution
    - not affordable
    - not acceptable to provider, client
  - Used, but quality inadequate

- **Used correctly and effectively**
  - Used incorrectly
Notes to Pathway from technology selection…..

• A wide range of factors determines the ultimate effectiveness of technologies selected to fulfill a health need. There may be multiple ways to achieve a hoped-for outcome (as with vaccines or diagnostics). However without adequate evidence or solutions, there may be no clear “best” approach. And even when a technology (such as male or female condoms) can demonstrate clear cost-benefits, it may not be available to target populations, may be too expensive (such as CD4 enumeration for HIV) or may not be acceptable to providers (family planning technologies) or users (condoms again).
Examples of mismatches between technologies and people range from that of household water filter products that take too long to treat enough water for busy households, or the challenge faced by women in high-risk occupations (such as prostitution) to ensure the use of male condoms.

A classic example of a technology-infrastructure mismatch is a device that requires a stable source of electric power proposed for contexts where stable power is a luxury. Another example is the use of diagnostic technologies (such as radiology or cancer pathology) in regions where diagnosed patients have limited access to treatment. Complex, delicate technologies are often inappropriate for settings where qualified service personnel are unavailable, or critical parts are unavailable.
Mismatch between technology and environment...

Inappropriate Technology perhaps?
Technology only effective if accompanied by...

- Knowledgeable and skilled users
- Clear practice guidelines and policies
- Effective financing and distribution to make them available
- Community efforts to bring clients into contact with health services in timely way

As one component of a broader health delivery ecosystem, appropriate technology is necessary, but not sufficient to ensure health services reach those who most need them.
Appropriate Technology Case Studies:

- Design Challenge
- Distribution Challenge
- System Support Challenge
Design Challenge: Woman’s Condom

• Result of a co-design process between PATH, women and their partners
• “Simple” product requiring advanced manufacturing processes

A need was identified by organizations working in family planning and sexually-transmitted disease prevention for a technology to bridge the technology-people mismatch described earlier. While male condoms have been proven effective, men control their use but are often reluctant to use them. A technology was needed to give women more control over condom use.
Woman’s Condom: Innovation

- Need for woman-controlled prevention methods poorly understood by industry and market poorly developed
- Public sector investment and technical leadership essential to drive innovation
- Public-private partnership vital for success

INNOVATE

Innovation was needed for both the technical details of female condom design and manufacture, as well as to understand the key attributes that would make a female condom socially and culturally appropriate. PATH needed to develop appropriate approaches not only to technology design (engaging women and their partners as co-designers) but to the public-private financial and distribution partnerships necessary to create a market for the product.
Distribution Challenge: Bednets (ITN)

- Technology innovation needed to support innovative distribution
- No “one size fits all” solution - adaptability is key to scaling-up in distinct markets

Image courtesy of Swiss Agency for Development and Cooperation SDC
http://www.poverty.ch/malaria-bednets
Notes to Distribution Challenge; Bednets

• Insecticide-treated bednets (ITN) for malaria control offer an excellent example of how truly appropriate technologies address obstacles within the broader health delivery ecosystem, as well as addressing the diverse needs of different populations and markets.

• The technical challenge involved combining innovations in two completely different products: bednets and insecticides. Development of long-lasting impregnated nets (LLIN) made it possible to provide two effective forms of vector control for the 2-3 year life of the net, but at an additional cost that created new challenges for dissemination. Numerous innovative distribution models, from compulsory purchases, to public sector subsidies, to free distribution to the most vulnerable populations, to public-private partnerships were used to ensure the nets achieved maximum distribution. Innovations in technology and distribution needed to work in parallel with similar innovations in behavior change communications to change attitudes towards malaria and generate demand for and sustained use of be bednets.
ITNs: Impact of AHT

- ITNs reduce overall mortality by ±20% in Africa; for every 1,000 children 1-59 months protected, 6 lives are saved per year.¹
- Kenya effectiveness study of pregnant women: 38% reduction in parasitemia, 28% reduction in risk of low birth weight, 25% reduction in adverse outcomes.²


Image courtesy CDC
www.cdc.gov/malaria/features/nigeria_bednets_program.htm
The case of ITN’s falls between product introduction and integration for market expansion along the product introduction continuum. To be successful, the effort depended on demonstrating the effectiveness of long-term bednet treatment technologies as well as deploying innovative business models that resulted in sustainable market-scale adoption and demonstrable positive health impacts.
System Support Challenge: Molecular Diagnostics

- Need for specific, simple, accurate and rapid infectious disease diagnostics

- Approach to adapt existing technology*: 
  - understand underlying principles 
  - break down to constituent parts 
  - simplify and adapt components to context

*image and text adapted from Harris, Kadir 1998. A low cost approach to PCR: appropriate transfer of biological methods. Oxford University Press
Notes to System Support Challenge; Molecular…..

Significant efforts have been made in recent years to develop highly sensitive, specific and precise diagnostics for infectious diseases in developing countries. The challenge is not just to lower the cost of complex equipment common in developed world diagnostic labs, but to make it possible to conduct rapid and accurate diagnostics tests using minimally trained staff, without the infrastructure (electrical power, clean water, available reagents, etc.) presumed necessary for sophisticated diagnostic techniques, such as polymerase chain reaction (PCR) techniques.

Note: The image shows how simple water baths can provide an effective and appropriate alternative to expensive thermocyclers used amplify DNA samples for the PCR process.
System Support Challenge: Strengthening Health Infrastructure

- Successful adoption includes training human resources, revising treatment protocols, re-aligning service structures
- Additional resources required to manage newly identifiable diseases (e.g. dengue, Chagas, cervical cancer?)
- New technologies aren’t a panacea- they complement but don’t replace proven methods

For an example of such a project, on your browser go to: www.ssilink.org
Notes to System Support Challenge; Health Infrastructure…

• An appropriate response to the diagnostics challenge must address not only significant technology hurdles, but equally the need to develop health system capacity to take advantage of accurate diagnostic information for medical treatment, prevention, and epidemiological surveillance. Introducing a sophisticated diagnostic method such as PCR requires not only developing processes and equipment appropriate for limited resource settings (this does not imply that high-tech solutions are the only option), but also training scientists, epidemiologists, clinicians and public health workers to perform the tests then interpret and effectively act on the results. Public and private sector organizations then need the means to implement preventative and curative measures.

• Advanced technologies such as molecular diagnostics are not a panacea. Different diagnostic contexts require different approaches. Simple microscopes may be the cheapest and most appropriate tool for primary care in health posts. Large-scale screening may best be done through serology. Virology is the appropriate tool to isolate pathogens for later study. Molecular biology tools like PCR allow sensitive, rapid and precise verification of pathogens detected through other methods.
System Support Challenge: Introducing new technologies

- Evolutionary innovation more common than revolutionary innovation
- Challenge ensuring institutional capacity exists to fully exploit new technologies or methods
- Technology’s role as catalyst for system change
Notes to System Support Challenge; New technologies

• The success of technologies newly introduced to a context is less of a design innovation problem, and more of a challenge to creatively adapt existing technologies and develop institutional capacities to make use of the outcomes.

• Technologies such as point of care diagnostics can provide a catalyst for system change. Cheap, easy to use diagnostics may enable village health agents to prescribe treatment that would otherwise require an expensive (or dangerous) trip to a distant clinic or hospital. Early, accurate diagnosis and treatment at the primary level can reduce costs throughout the health system.
Public Private Partnerships for Appropriate Technology Development

- Financial, developmental and clinical risk reduction is a critical challenge to the success of appropriate technologies.
- Private commercial partners bring technical and market expertise to reduce development risk.
- Public partners can aggregate demand, strengthen delivery systems, facilitate organizational links, and champion development of favorable health policies.

When developing health technologies for poor populations, commercial partners can often provide essential technical expertise and innovation, and public partners can reduce risk through developing unique partnerships, clarifying the market and strengthening delivery systems. For example, WHO played a key role in enhancing surveillance activities, facilitating links with African ministries of health, and providing a sound introductory platform for the Meningitis A conjugate vaccine.
Public Private Partnerships: Bridging market gaps

- PPP’s can address the disconnect between market incentives and public health needs
- Successful technology introduction depends on organizations with the capacity to identify complementary objectives and capacities among partners
- Participation of public agencies in solution design is often key to the success of appropriate health technologies

For an example of such a project see information about the PATH/WHO Meningitis Vaccine Project. On your browser go to: www.meningvax.org
Notes to Public Private Partnerships

- A public sector nonprofit organization, such as PATH, can help to successfully bridge gaps between public health needs and commercial interests through public-private partnership. Developing effective public-private partnerships requires attention to many factors such as the state of the science, the identified market for the product, and the complexity of intellectual property issues. Effective partnerships must solicit and follow guidance from developing country leaders on a variety of issues such as product presentation, cost, communication and introduction strategies.

- Resources: PATH’s Guiding Principles for Private Sector Collaboration
  http://www.path.org/files/ER_gp_collab.pdf
Summary: Appropriate Technology

• Concept popularized during the ‘70s environmental movement
• Associated with global health at Alma-Ata 1978
• WHO definition:
  – Scientifically valid
  – Adapted to local needs
  – Acceptable to users and recipients
  – Maintainable with local resources
• Solutions co-designed with end-users and providers
Summary: Appropriate Technology

- Technology development: using Rapid Evaluation framework (RAVE)
- Technology component of broader ecosystem including People and Infrastructure
- PATH introduction framework: Innovate-Introduce-Integrate
- Case studies: Design challenge, distribution challenge, system support challenge
- Value of Public-Private Partnerships to bridge market gaps
Credits

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