Information Technology, Primary Health Care and Universal Health Coverage

Abstract

The importance of strengthening Primary Health Care (PHC) has been repeatedly emphasised and reemphasised. Yet PHC is understood and practiced largely as illness care. All preventive measures are addressed as separate entities under vertical programmes. Thus, resources invested into a single-disease project divert resources from PHC and the strengthening of the health systems, away from addressing determinants of health. Conflicts of interests do not allow development of comprehensive PHC. Universal health coverage is attainable if Information Technology is appropriately used in PHC. Focus needs to be placed on the maternal and child health care, as interventions to this group is most cost effective and has life-long positive impacts, even for future generations. Midwives, and the antenatal care they provide, are crucial to preventing the complications and illnesses that lead to maternal and child mortality. These comprehensive roles have been inadequately recognised in a conclusion of the *Lancet* 2014 Midwifery Series that remains relevant today. Moreover, women and children are the largest sub-set of any population served by primary care providers. Self-organised communities receiving reproductive and child health, including growth monitoring, can change the face of PHC and thus the state of health in a population. Advances in Information Technology available today and its progressive use by the health care providers and the public, facilitates to attain Universal health Coverage.

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Primary Health Care leading to Universal Health Coverage

Backing up human intelligence with Artificial Intelligence (AI) is a powerful tool in achieving sustainable development goals. The Alma-Ata vision of health system rooted in primary health care is as relevant today as it ever was.[1,2,3] Unfortunately, primary health care workers spend all their time treating illnesses with drugs, and prevention of the causes of these illnesses is woefully neglected. Primary Health Care (PHC) is meant to prevent disease rather than only waiting to treat it.

Better utilisation of simple observational data at primary care level is the key to universal health coverage. Improved collection of this data and its efficient use will greatly help to improve maternal, new born, child and adolescent health (MNCAH), where morbidity and mortality is at its highest in low and middle-income countries (LMICs). Outcome of pregnancy and survival of the mother and the new born, are two key areas that will significantly benefit from better use of information technology (IT). Moreover, informing primary care providers of the cause and effect of disease among those they serve is much more meaningful in continued medical education. Improvements in indicators over time, further boost morale among health workers in their daily struggle. Leveraging the power of AI techniques for large-scale screening has the possibility to accelerate improvement of population health in several facets of health care.[4] Available IT today makes it affordable for use in every primary health centre and the district hospital to improve the health of populations.

2020 is considered AI and optimization of IT year. WHO published a set of guidelines in 2019, pointing out substantial innovation opportunities in digital health for health care providers and encouraging its adoption around the world.[5] AI-driven health interventions could lead to improved health outcomes, but optimal use of information technology at primary care remains a distant goal, especially in LMICs.[6] Interest in digital health, which comprises overlapping areas ranging from AI, the internet of things, electronic health, and telehealth to the analysis and use of big data and use of technology, also opens up possibilities of digital virtual clinics for under-fives growth monitoring and other preventive programmes.[7] Even though some innovative PHC service providers in LMICs are using applications to improve the health service provision, efforts remains sporadic.[8] PHC is still exceedingly inclined towards illness care, rather than having a healthy balance between prevention and cure.[9]

Many international peer reviewed medical journals are highlighting the scope of using AI in most aspects of health care delivery, e.g. the recent inclusion of digital-health in the Lancet family of journals. Smartphone ownership among doctors and nurses, even in LMICs[10], is continuously increasing and is almost universal. They perceive these devices to be useful when performing their clinical duties. Large

numbers of staff are sending patient-related clinical information using smartphone messaging modalities.[11,12] Regrettably, the use of technology is rare in PHC for basic preventive approaches, in spite of the fact that AI holds tremendous promise for transforming the provision of healthcare services in resource-poor settings.[13] Constant increase in public use of phones and the internet makes it possible to disseminate information critical for life threatening health problems, timely utilization of PHC, improved healthy behaviour and hence, health status.

Accurate timely information from routine data is the key to PHC. Many aspects of the science, the practice of information processing and the engineering of information systems has remained detached from the PHC model.[8] Although health information is collected and collated at health centre level and passed on to regional and central level for analysis, the first line of health care providers, who are generators of this information, rarely see the relevant end product of data or are given required feedback.

The application of information processing involves both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, health data, and knowledge for communication and decision making.[14] It supports Health Management Information Systems and secures the exchange of health information between consumers, providers, and quality monitors. Health information sharing between patients and providers helps them to understand disease, improves diagnosis and empowers patients and the public through interest in self-care. To quote Cosgriff and Celi, *"The machine learning community flocks to specialties where datasets exist—radiology, ophthalmology, critical care medicine—rather than paediatrics, obstetrics and gynaecology, surgery, or primary care and mental health, where machine learning can have the biggest impact… A better roadmap is needed to leverage the value of machine learning and derive knowledge from health data we collect in the process of care".*[15] Routine observation data has far greater potential in PHC than randomised controlled trials, especially in obstetrics and gynaecology and child health, where the need is greatest.

Women and children, together, make up the bulk of the population served by primary health centres and easily comprise over two third of the total population. Any interventions addressing their health needs and rights[16] will improve the extraordinary burden of morbidity and mortality experienced by this group. Midwives, and the antenatal care they provide, are crucial to preventing the complications and illnesses that lead to maternal and child mortality. These comprehensive roles have been inadequately recognised in a conclusion of the *Lancet* 2014 Midwifery Series[17] that remains relevant today. Primary health care providers, especially midwifery services also go beyond assisting childbirth to caring for pregnant women, neonates, and families, as well as providing family planning and reproductive health services. There remains a need to champion midwifery as a profession, and ensure that all women have access to these services.[18] Here again, maternal and child health and related services' data, is crucial for improving the health of the population. Unfortunately, maternal and child health services also utilise the medical consultation model, addressing mostly symptomatic needs. Preventive health measures and education, supported by local health information, is not the norm. Limited preventive services, that may be available at the health centre, are only availed by those who attend health facilities for whatever reason, whilst the majority of women and children in the community miss out completely, yet many of them may have even a greater need.

Women of reproductive age need comprehensive maternal health care including nutritional education, adequate care before, during and after pregnancy and family planning information and advice. To maintain a healthy child, birthweight, postnatal care of the mother and the baby, continuous and regular monitoring of growth, and immunisations are important areas where basic information will facilitate and ensure optimal growth and survival. Paradoxically, this information is widely available but rarely used. PHC for all is pointless without counting and accounting for important events. In the absence of readily available numerators and denominators, measuring progress is impossible.

Use of available technology, at almost no extra cost, can make provision of services and universal health coverage possible in LMICs. Most significant use of technology is discussed below:

1. **Denominator:** An important component for PHC provision is the base population or age-sex register (In the UK, each general practitioner has a full age-sex register of the population served, making universal health coverage a possibility[19]) for each village served by the primary health centre. It serves to calculate total workload for the population to be served. Health centres need

to establish this register for the villages and for the catchment area, before effective PHC can be delivered to the population served. The population register serves as *denominator*, the figure representing the total population in terms of which statistical values (indicators) are expressed. It also provides the total numbers of the *sub-groups of the population for various services* e.g. the under-fives for growth monitoring and immunization services or the women of reproductive age for family planning.

Vital statistics, especially births and deaths, are, by law, required to be collected throughout the world at source. Although getting better, it is not always complete and accurate. The population register is the starting point where event registration updates takes place. Many primary health centres do hold this information from the national census data (personal experience in many countries). Technology allows download of this data electronically; however, it requires regular updating for births, deaths and migrations. Reporting of births and deaths, being a function of village administration, the Village Health Worker (VHW) can be entrusted with this responsibility. Supervision from district health information officers, can further help in quality assurance and completeness of the data. Once established, the age-sex register is easy to maintain electronically. Routine review of weekly/monthly moving averages are simple to develop and a spreadsheet can easily highlight sudden changes.

Civil registration and vital statistics (CRVS) and the data they generate is crucial for monitoring implementation of the Sustainable Development Goals (SDGs) in countries, as well as for other national and regional health and development agendas.[20]

2. **Data collection and collation:** Some form of Health Information Management System (HMIS) already exists in most countries. At primary health centres, nurses and information officers are tasked with collection and collation of predetermined data sets and pass these to the district health office, where data is collated from all health centres in the district. Finally, the central bureau of statistics analyses the data at country level for use in planning and monitoring health. Data collection is a process, whilst its ultimate aim is to improve health indicators - the outcome. Appropriate IT, such as smart phones or tablets, can transform the process of data capture at the point of service delivery and transfer. It releases the information officer from the mundane task of data entry from paper to computer and checking on the errors, but also it frees the information officer to do other things for which they are trained, such as data analysis and dissemination of information to PHC and to inform the community of the state of health and the way forward to improvements in health.

3. **Maternal, Newborn Child and Adolescent Health (MNCAH):** The continuum of care is the core principle of programmes for MNCAH and as a means to reduce the morbidity and mortality burden.[21] Yet vital information of MNCAH data is rarely reviewed at primary health centres. Regular review of this data serves as the most important health information in assessing and monitoring the health of a population:

   a. **Child Health:** Data on live and still births[22] and rate of stillbirths has largely been underestimated and reliance on periodic Demographic Health Surveys[23] is the norm. Birth weight, a critical indicator[24]; perinatal, neonatal, infant mortality add up to form indicators which require continuous monitoring to improve the health status of a population. Careful vital registration, in addition to early childhood mortality, must be reviewed at PHC level.

   b. **Growth Monitoring:** Growth monitoring (GM) is one of the most neglected areas of child health in primary care. Every child has a right and deserves to receive this basic service. Over one third of all under-fives are under nourished in LMICs.[25] Malnourished children are prone to higher morbidity and mortality, and stunting deprives them of optimal growth, even affecting their performance in school.
   Web based growth monitoring software, the WHO Anthro is available free of charge. It allows individual as well as cluster (village under-fives) growth monitoring with a built-in reporting mechanism. Its *ad hoc* users have benefited from it, but rarely used in PHC as a growth monitoring tool for under five population. Prevention of malnutrition among children, especially in the first 1000 days, not only reduces morbidity and mortality but also has lifelong health benefits.[26] Coexistence of overnutrition (overweight and obesity) alongside undernutrition (stunting and wasting), at all levels of

the population, need to be addressed simultaneously.[27] Prospects of future capabilities to develop the child growth monitor app that helps scan children in three dimensions using infrared sensor provides the exact measured values of the body to derive the nutritional status.[28]

   c. **Maternal Health:** Family planning services, breast feeding, antenatal care, supervised delivery and postnatal care are key in improving outcomes of pregnancy.[29] Most of this data can be captured on electronic devices in health centres and district hospitals. Although this data is routinely collected on paper, it is rarely analysed and used by health facilities. By law, birth registration and outcome of pregnancy is recorded in obstetric registers in all health facilities. A simple computerised spread sheet of obstetric data can provide useful information to improve the quality of MNCH services as well as for purposes of training. A four decades use of obstetric register demonstration from Papua New Guinea is commendable.[30]

   d. **Immunisation** status, of both mother and child, forms an important indicator. Sheer numbers of children or mothers immunised is of little use. It is important to determine the proportion of under two years and all pregnant women completing the routine immunisation schedule, rather than relying on "catch-up" campaigns. Incorporation of routine immunisations in the growth monitoring programme/clinic in each village is the simplest way to achieve this. The age-sex register further assists in completeness of the coverage.

   e. **Adolescent Health:** Unhealthy life styles and a background of stunting in early childhood makes adolescents more vulnerable to later-life health problems, including chronic conditions.[31] Sexual activity among teenagers leading to unintended pregnancy and sexually transmitted infections (STIs) are other serious problems. A stronger focus on social-structural determinants and broader aspects of sexual health[32] is required to minimise teen pregnancy and STIs.

   Linking under-five growth monitoring into continued growth monitoring in schools provides an opportunity for advice and education in schools to address these issues. The WHO Anthro Plus package allows monitoring of school children 5-19 years, which can help address undernutrition as well as overweight problems and an opportunity for further discussions on other health issues affecting adolescent and their future.

4. **Other morbidity data:** Once the HMIS is converted from a manual to an electronic database, this data is easily accessed, identifying necessary points of intervention for improvements. Add-ons are also easy once the HMIS is electronic. OpenMRS in Kenya and DHIS2 used in more than 40 countries in Asia, Africa and Latin America are some examples[11], however there are cost implications. Capturing MNCH data electronically, at the time of service provision and analysis at health centre/district level for feed back to health service providers is critical. Sharing results and crediting health workers, not only raises their morale but also improves the quality of service and the data. A successful experiment demonstrating applicability of this approach serves as an example from Laos.[33]

5. **Healthy Life Style:** Adolescent health logically should progress on to adults. Poor understanding of modern life style and non-communicable diseases (NCDs) is a major health issue. High levels of obesity, diabetes, high cholesterol and other chronic diseases are on the rise everywhere in the world. The COVID-19 epidemic is further providing evidence that persons with underlying health conditions are at a higher risk of dying.[34] PHC cannot ignore it as LMICs are in the grip of a dual burden[35] of infectious diseases and NCDs. A regular assessment of weight and height (BMI) and its relation to diet through "well people clinics" will become an important service in the not too distant future. This service, under the private sector, is freely available in big cities in LMICs, but at a cost that few can afford. To attain UHC, PHC must make this service available to all. Chinese experience serves as a lesson for the world, how basic health care for all has reduced the burden of chronic diseases and disabilities.[36]

Available Tools

Tablets and smart phones are popular and no areas are considered remote for these devices. Over half the world's population can access the internet, and mobile phones are becoming universal.[37] A study in Lesotho found that only 21.5% of the population in the project area had no phone. The Public Health Baseline study, in the same population, used tablets with Microsoft Access for data collection. The local internet service was used to transfer data on the same day to a central unit or within days where internet access was a problem.[38] Another study in sub-Sahara found smartphones with 39% of all SIM connections in 2018, and estimated it to rise to 66% by 2025.[39] Health care workers are great users of information technology as they already use smart phones, personal computers and tablets, along with access to the internet. In the most recent COVID-19 epidemic, China, Singapore, and South Korea have all used smartphones to track contacts and Australia has considered the same. The cost of IT required for boosting PHC is affordable and there is little reason to believe that primary health centres cannot use the technology for universal health coverage.

All office personal computers (PCs) come with Microsoft Excel and Access database. Electronic data can be easily transferred to PCs for analysis and reporting. Child birth and obstetric data in each district hospital needs to be computerised so that the information can be used, both for surveillance and continued medical education purposes. Primary health care nurses and information officers, with minimal training, can use the technology to improve population health. Free packages like WHO Anthro and Anthro Plus for growth monitoring are the best tools for data capture and reporting for under-fives and school children. Data from spreadsheets can help with basic analysis. For further analysis it can be imported into Epi-info, which is also available free of cost from CDC. This is not to exclude more sophisticated data bases such as SPSS© and other software; however, there are cost implications.

The Future

Box 1 summarises the kind of data required for PHC (most of it is already collected but rarely used locally), its sources and possible indicators to be used at primary health care for monitoring and continued medical education. Views expressed in this paper are that of a public health specialist, who has used these approaches and values power of information in health and development.

This is not an exhaustive review of what is required and can be achieved, but a start for a discussion on the massive gap in data collection, analysis and usage which is blindingly obvious. Huge sums of money have been spent on demographic health surveys and other methods of estimating the population health needs. A fraction of this money can change the face of PHC for ever. MNCAH data from each health centre and its cumulation to districts and regions would be timely, cost effective and efficient; providing surveillance data as well as a wealth of information for much needed in-service education to service providers. Working from a bottom up approach will also improve the quality and completeness of the data, leading to reliable information in near future. To quote Seya Abimbola, "To make global health truly global is to make global health truly local".[40] Health workers would relate better to their own data and information rather than national data or that from other countries. Home-grown information is needed even more today in the presence of myths, fake news and conspiracy theories against the known benefits of modern treatment to educate the public.

There is enormous potential for IT to promote health by using messaging services for health education for VHWs and the public. An ATM type "Hole in the Wall"[41] in health centres and schools with free access will go a long way to educate rural youth and communities. Various applications and software packages can be used effectively to make people aware of the health issues affecting them and to promote their health and that of their community. Simple protocols for dealing with serious health problems, especially complications of pregnancy, can be made available for remote health workers to stabilise patients before transferring them, reducing delays in secondary level lifesaving treatment.

The effect of digital health solutions and interventions related to health outcomes as succinctly compiled in the flow chart by Holst et al is, effectiveness, efficiency, and quality in health facilities; aggregation of health data for policy makers; disease management and prevention; patient tracking and safety; universal health coverage; health system performance; and acceleration of the sustainable development goal agenda.[34] Familiarity with the Declaration of Alma Ata for Primary Health Care is striking.

Conclusions

The importance of universal primary health care has survived tumultuous changes in health service delivery, at least for forty years. Whilst many rich nations have achieved universal primary care, the sheer size and universality of this task has planted doubts in the minds of governments and health experts in LMICs, remaining busy with cure rather than prevention. Illness care is only to keep an individual alive and well, so that further preventive interventions might enhance the quality and longevity of life. There could not be a better time to support and promote PHC for its sustainability using modern information technology, as we have the knowhow and the tools to attain this goal. Availability of appropriate health information empowers the health care provider to understand the health problems and serve populations better. Consciousness on the part of those who govern and implement the health services is paramount. Prevention currently is limited to vertical approaches to often single health issues. This is replicated separately for each issue by outside teams, rather than to allow primary health care providers the responsibility. Obsession with illness care needs to be redirected to prevention in PHC. Data collected at primary health centers should largely benefit the health care providers and local communities. Optimum use of information technology can strengthen PHC to achieve the ultimate goal of Universal Health Coverage. We have a challenge on our hands to be balanced in *what we know* and *what we do*.

Box 1. Example of data required at Primary Health Care (PHC) for Universal Health Coverage

Complete age-sex data for population served by Primary Health Centre	Source	Indicators
Mother – Age-sex (A/S) Register and hospital records		
• Fertility Rate	A/S Register & pregnancies	Total Fertility Rate
• Anaemia	Antenatal care	% among ANC
• HIV/Syphilis and related	Antenatal care	% Positive & treated
• Antenatal 3+ visits	Antenatal care	% Pregnant women
• Delivery – Institution or home	Birth Register	% supervised
• Spontaneous or assisted	*A separate analysis of birth register data is required*	% Normal deliveries
• Complications of pregnancy	*for improvements and training*	% complications and type
• Outcome – Live or stillbirth	*Regular Audit of Obstetric Register*	Live & Stillbirth rates
• Maternal Mortality		Near Maternal deaths and deaths
• Postnatal care	Primary Health Care	% receiving PNC
• Breast feeding	Primary Health Care	% Exclusive Breast Fed <6month
• Contraceptive Prevalence Rate (F15-49)	Primary Health Care	% Modern method and Total
Children (0-5 Years) – Age-sex Register and hospital birth register		
• Birthweight	Birth Register	% <2500 Gms. & > 4000 Gms.
• Postnatal care -7 days	Primary Health Care	% PN Mortality
• Routine Immunisations	Primary Health Care	% <2 Year Coverage Rates
• Growth Monitoring	Monthly Clinics	% Monthly village clinics held
• Underweight, wasted and stunted	WHO Anthro	% Malnourished
School Children (5-19 years) – School Health Programme		
• Growth Monitoring	Monthly assessment	% Events at school planned
• Underweight (BMI)	BMI-WHO Anthro Plus	% BMI <18
• Overweight (BMI)	BMI-WHO Anthro Plus	% BMI >25
• Anaemia, other parasitic infections	School Health Program	% anaemic and with parasites
• STIs	School Health Program	% diagnosed (M&F)
• Teen Pregnancy	School Health Program	% Teen pregnancies
Notifiable infectious diseases		
• Notifiable infectious diseases	Notifiable infectious disease register	Notifiable disease rates

Note: This methodology can be extended to adults at PHC gradually

Acknowledgments

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