Saudi newborn screening

A national public health program: needs, costs, and challenges

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ABSTRACT

A Saudi newborn screening program is important to the half million Saudi children born each year in the Kingdom of Saudi Arabia. It is a coordinated and comprehensive system consisting of education, screening, diagnosis, treatment and management, follow-up, and program evaluation. The Saudi newborn population should benefit from this program and affected infants will be diagnosed early, and managed effectively. Both cost effectiveness, and cost benefit justifications are presented. Funding for the program can be a public health challenge. We offered recommendations to achieve this vital program.

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The principles and goals of newborn screening for metabolic disorders have been discussed and debated for the last 40 years. Many of the basic ideas remain unchanged with the principle goal being prevention of serious morbidity, and death from a potentially treatable disorder by identifying affected infants before development of symptoms. Ideally, newborn screening is a public health program that is capable of detecting certain disorders that may not otherwise be identified before they manifest clinically with developmental disability or acute crisis that may cause death. It is an essential program that aims to ensure the best outcome for those affected with the disorder. However, there are expected cost-benefit arguments that will be aimed at the public and at Kingdom legislators and stakeholders. In addition, significant cost burdens and unclear payer(s) have to be assumed by individual families, insurers, or the Ministry of Health (MOH). Furthermore, increased utilization due to improvements in the newborn screening system, and the expansion of the number of conditions for which screening is offered, will further increase the program costs. Despite widespread acceptance of newborn screening, efforts need to be made to overcome some significant problems. The Saudi public health system will face many challenges as newborn screening capabilities continue to evolve. The health care service infrastructure is currently limited with regard to the interconnections among primary care professionals and sub-specialists, particularly in remote and under-developed areas. There are geographic limitations in the availability of specific expertise for many of the rare conditions, and considerable needs exist in the areas of training and education on disorders detected through newborn screening programs. Unfortunately, many programs provide for screening and diagnosis, but they are limited in their ability to ensure long-term management, including the provision of the necessary treatment and services. This may defeat the purpose of these vital screening programs.[1,2]

Need for Saudi National Newborn Screening Program (SNBS). Currently, the Saudi Arabian health system has no mandatory unified neonatal screening program. Increasing efforts are evolving to establish such programs under the direction of the Saudi MOH and other Saudi health services centers (namely King Faisal Specialist Hospital and Research Center [KFSH&RC] and Prince Salman Center for Disability Research [PSCDR]). The SNBS is a public health prevention system for early disability, and mental retardation prevention. It has functions that go beyond just testing and include follow up, diagnosis, treatment, and evaluation as necessary.[3] In some countries, national newborn screening programs have been successful. In both the United Kingdom and Japan, these programs are well established for a defined set of metabolic, genetic and endocrine disorders.[4,5] In the United States

of America (USA), newborn screening programs are state-based, so the number of tests performed, retesting guidelines, and other important issues vary from state to state. An effort is underway to establish a national program with uniform guidelines and procedures for implementation and management.[6] The diseases identified through screening allow effective treatments to be started before irreversible neurological damage has occurred, and thus preventing lifelong disability. Recently, there has been a trend to expand newborn screening programs to include testing for almost 49 disorders.[7] Greater collaboration between professionals undertaking key roles in screening is required to ensure that the expanding program can be delivered to a high standard. To support this collaboration for the newborn screening program, many countries have developed centers with clear policies to guide the program and have set out a framework for its performance management.[8] The Saudi MOH reported 460,000 newborns delivered in the year 2003,[9] and it is expected to exceed half a million newborns by year end 2006. There is a high national incidence of neonatal metabolic rate (defined as the ratio of newborn diagnosed with metabolic disease to the total newborn population during one year). Saudi MOH reported neonatal metabolic rate of 1:1000 per year as compared to other international rates (USA 1:4000, Japan 1:7000).[3] This high potential case load urges for a national newborn metabolic screening program. Saudi newborns may benefit from this screening program with a potential yield of approximately 500 new cases per year that could be detected early and the underlying disorder controlled or the damage prevented, saving both the patient a life long disability, and the national health system a great expense.

Both PSCDR and KFSH&RC, in collaboration with the Saudi MOH, formed a task force on newborn screening that made valuable recommendations. In the year 2004, a phase I (SNBS-I) was launched. Currently, the SNBS-I has a blood sample (dry blood spots [DBS]) load of approximately 50,000 tests per year. This phase aims to screen 120,000 dried blood samples by year end 2006. These collected DBS are processed using Tandem mass spectrometry (MS/MS) and immunoassay/ fluorometric assays. It is planned to have Saudi newborns in all Kingdom areas screened in 4-10 years based on funding availability.[3,10] Considering the existing differences in genetic background, and metabolic inheritance of the Saudi population as compared to published non-Saudi genetic and metabolic studies, both KFSH&RC and the MOH were able to identify 15 newborn screening tests relevant for the Saudi population. The following are conditions currently tested for at SNBS-I; (argininosuccinic acidemia (ASA), beta-ketothiolase deficiency, biotinidase deficiency, citrullinemia, congenital adrenal hyperplasia, congenital hypothyroidism, galactosemia, glutaric acidemia type-I, 3-hydroxy-3-methylglutaryl-coenzyme A (CoA) lyase deficiency, isovaleric acidemia, maple syrup urine disease. medium chain Acyl-CoA dehydrogenase deficiency, methylmalonic acidemia, phenylketonuria, and propionic acidemia).

Cost effectiveness and cost benefit. Costs and benefits related to screening for potential newborn conditions were evaluated in other countries (US, Canada, and Japan) after mapping them over major disease outcomes (namely life expectancy, cerebral palsy/stroke, seizures, developmental delay, hearing loss, and vision loss). The results of these analyses indicate that most newborn screening programs improve outcomes and reduce overall costs. Further, technologies such as MS/MS or high performance liquid chromatography (HPLC) save money due to their multiplexing capabilities and low screening false-positive rates. The identification of potentially affected individuals at such an early time in life leads to many years over which the benefits accrue and aggregate over costs.[11] Many believe that screening, as a tool for prevention, is a way to reduce costs.[8,12] In addition, it may avoid costs that otherwise would have been incurred within the health care system as a whole, or outside the health care system. However, screening may increase, not reduce, the cost of a public program in the short term. Economists and health policy analysts use 2 types of calculations; cost benefit and cost effectiveness to estimate the potential for savings, potential for averting costs, and potential for achieving benefit in reduced mortality and morbidity. In the USA, the current cost of the newborn screening test is USD 69.50 per newborn, which screens for 50-60 disorders. Typically, this testing cost is covered by health insurance.[13]

Cost-benefit calculations attempt to value everything, including health effects, in terms of dollars and in the case of newborn screening for particular conditions, it is the cost of screening and treatment minus costs prevented in dollars.[12] Although this makes it easier to perform comparisons, many people object to the ideas that human lives and health can be represented by dollars. Also, there is disagreement on what monetary value to assign. However, the goal of the intervention (in this case screening) is to save lives, prevent disability, and reduce public medical expenditures. Alternatively, cost-effectiveness analyses compare the cost of doing something to the cost of doing nothing, or of doing something else. It is useful in showing which alternative is preferable.[9] One study assumed a 20-year difference in life expectancy between affected patients diagnosed late (life expectancy of 45 years) and those diagnosed early by screening (life expectancy of 65 years).[14]

The effect of early, pre-symptomatic diagnosis of most congenital or metabolic disorders will be primarily on quality of life rather than mortality. To account for this effect, it is advisable to adjust mortality for quality of life. Estimates of utility level of patients with serious neurologic defects range from 0.15-0.30 (normal value of 1). Early detection of a congenital or metabolic disorder was estimated to result in the addition of between 0.70 and 0.80 quality adjusted life year (QALY).[14] If one assumes a congenital metabolic/genetic disease that occurs approximately once in every 1,000 births per annum in the Kingdom of Saudi Arabia and establishing a newborn screening program will cost Saudi Riyals (SR) 150 per sample; thus, approximately SR 150,000 is spent to detect one case. In addition, untreated severe disability care for, say, 30 years (using 0.4 QALY) in an institution at a cost of SR 100 a day, would run to SR 1,095,000, more than 7 times the cost of prevention. (Cost benefit ratio of 1:7). Add to this saving the input from the treated individual through earnings, and family and societal contributions. The expected cost of a SNBS for testing only (other extra expenses may include; program launching, equipment, sample collection, transportation, staff education and training, research and analyses) will exceed 20 million dollars (or 75 million SR) per year. Cost-benefit considerations have, in the past, contributed to the trend to add new tests. An additional test adds only a marginal cost, since the same system can be used for collecting and transporting specimens and recording and reporting results. Not all medical interventions need to be cheaper than the alternative. Moreover, many medical interventions bring new problems in their trains. But these remarks do suggest that some considerations have been systematically ignored, thus distorting the ratio of benefits to costs.[11,14] Another potential benefit is the use of program database information in identifying certain populations of high genetic/metabolic prevalence and offering them appropriate pre-marriage counseling.

Challenges. Challenges facing any newborn screening program are mainly in areas of financial coverage, demographic distribution of newborns, public awareness, professional buying-in with the program, logistics of proper sampling, collections, transportation, and reporting mechanism. Importantly, the development of a national database for these disorders will need a robust network of specialists, scientists, and analysts to further analyze data and pick up cases and offer counseling, treatment, and follow up for patients and their families. Considering the Saudi newborn screening program, challenges will be to develop the local experience with Saudi genetic, endocrine, and metabolic burden of diseases given the appropriate genetic chase. In addition, the program must consider incidence, morbidity of the potential disorders, available treatment, and interpretation of abnormal results. Appropriate selection of tests to suit the Saudi newborn population will be needed with acknowledgment for future expansion of such a program. Patient access from across the Kingdom to the program sites is paramount in view of the geographic limitations, the retesting issues, and follow up for the identified cases. Stable and continuous program funding will depend on recognized payers. Possible sources for funding may include, but not limited to: fees for testing charged directly to patients, fund raising by public campaigns, coverage by health insurance, budget from the Saudi MOH in addition to charity fund raising efforts. The Saudi newborn screening will need both a dynamic "program registry" and a continuous "program evaluation" (namely effective case-identification, setting priorities, improving information system, and use of evidence-based approach to make a new or added tests). Additionally, surveillance and research will support both program activities and performance measurement. Usually, such program development will be technologically dependent with recognized ownership at specified centers. Currently, this role is played by both PSCDR and KFSH&RC. Also, program "database maintenance" will be essential in data reporting, analysis, publication, and management. Undoubtedly, program logistics can pose challenges in areas of; collection, transportation of samples, limited laboratory capacity, possible budget constraints, and bureaucracy of policy makers. The "Medical home" which is an emerging health concept can link to the Saudi newborn screening program and offer support to identified parents before or after birth of index cases. Ethical issues for future testing, and data sharing will have to be addressed (issues of sample storage and future use of residual blood spots, and legal regulations). Ultimately, the Saudi newborn screening program has to be transferred to MOH as a public health preventive service program. There is a need for a Saudi uniform national newborn screening program that involves government, professionals and consumers to further develop and expand the SNBS system. Ideally, all newborns should be screened for all disorders for which effective treatment is available. These disorders can be grouped into 5 categories: Amino acid metabolism disorders, organic acid metabolism disorders, fatty acid oxidation disorders, hemoglobinopathies, and others (namely congenital hypothyroidism, cystic fibrosis, hearing loss, congenital adrenal hyperplasia, galactosemia and biotinidase deficiency). The Saudi MOH central laboratories is the best solution to offer a vital national newborn screening service. This can be accomplished by assembling an advisory committee

(namely Newborn Screening Expert Group), which will help to oversee the program. Endocrine and metabolic professionals and representatives from all health sectors in the Kingdom are required to select and prioritize the screening tests. Ideally, the MOH can assign program development to an appropriate third party with subsequent transfer of program ownership to the MOH. Fund raising will be required to establish and maintain the program, ideally from an assigned budget of the MOH- public health prevention services and from coverage of health insurance companies. Additionally, donations could be obtained from pharmaceutical companies, contributions from community businesses and charity donors. Critically important, the MOH will first have to provide the newborn screening program with trained staff, and assure program "quality performance". Secondly, the MOH has to establish a network of collecting all the proper samples and centrally processing them in a uniform manner. Thirdly, an effective referral system to care for the diagnosed cases with their close follow-up, and an efficient reporting procedure should be standardized with effective short-term follow-up. Reports of confirmatory results should also be obtained. Fourthly, the MOH has to adopt the appropriate technology tools in processing samples and communicating with the MOH central laboratory.

Finally, maintaining a program quality assurance involving diagnostic and follow-up system along with long-term data collection and surveillance is pivotal.

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References

1. Alexander D, van Dyck PC. A Vision of the Future of Newborn Screening. ***Pediatrics*** 2006; 117: S350-S354.
2. Watson MS, Mann MY, Lloyd-Puryear MA, Rinaldo P, Howell RR. American College of Medical Genetics Newborn Screening Expert Group. Newborn Screening: Toward a Uniform Screening Panel and System. Executive Summary. ***Pediatrics*** 2006; 117: S296-S307.
3. Prince Salman Center for Disability Research. Saudi Program for Newborn Screen [Pamphlet]. Year 2006. Available from: URL: http:www.pscdr.org.sa
4. Department of Health. Standards for better health [Online]. 2004. Available from: URL: http:www.dh.gov.uk/assetRoot/04/08/66/66/04086666.pdf
5. Aoki K. Newborn screening in Japan. Southeast Asian. ***J Trop Med Public Health*** 2003; 34 Suppl 3: 80.
6. American College of Medical Genetics. Newborn Screening: Toward a Uniform Screening Panel and System. Final Report. 2005 March 8. Available from: URL: http://mchb.hrsa.gov/screening
7. Schulze A, Lindner M, Kohlmüller D, Olgemöller K, Mayatepek E, Hoffmann GF, et al. Expanded Newborn Screening for Inborn Errors of Metabolism by Electrospray Ionization-Tandem Mass Spectrometry: Results, Outcome, and Implications. ***Pediatrics*** 2003; 111: 1399-1406.
8. American Academy of Pediatrics, Newborn Screening Task Force. Serving the Family from Birth to the Medical Home. Newborn Screening: A Blueprint for the future. A call for National Agenda on State Newborn Screening Program. ***Pediatrics*** 2000; 106: S389-S422.
9. Al-Rabadi MS. Studies of Saudi Arabia population. Riyadh (KSA): King Fahad Library Publisher; 2005.
10. King Faisal Specialty Hospital & Research Center, Saudi Program for Newborn Screening [Pamphlet]. 2006. Available from: URL: http://Rc.KFSHRC. edu. sa/BMR/sections/MSL
11. Carroll AE, Downs SM. Comprehensive Cost-Utility Analysis of Newborn Screening Strategies. ***Pediatrics*** 2006; 117: S287-S295.
12. General Accounting Office. Newborn Screening: Characteristics of State Programs. Washington (DC): General Accounting Office, [Publication]; 2003. Available from: URL: http://www.gao.gov/new.items/d03449.pdf
13. Wisconsin Newborn Screening Laboratory Newsletter: Re-defining NBS Disorders. Newborn Screening Newsletter, No. 59: July 2005. Available from: URL: http://www.slh.wisc.edu/newborn/newsletters/Re-definingNBSDisorders.php
14. Schoen EJ, Baker JC, Colby CJ, To TT. Cost-Benefit Analysis of Universal Tandem Mass Spectrometry for Newborn Screening. ***Pediatrics*** 2002; 110: 781-786.