An Electronic System to Assist Schools in Determining the Health Risk of Students

Paul Villas, D.Ed., CHES
Zhixiang Chen, Ph.D.
Doreen Garza, MPH
David Salazar, MS

Abstract: The University of Texas-Pan American Border Health Office collaborated to build a web-based information system due to requests by Texas school nurses who were screening children for acanthosis nigricans. Acanthosis nigricans is a black-brown velvety marker that mostly appears on the back of the neck and is associated with hyperinsulinemia and obesity. The system utilized a web browser application. It produced electronic forms and is interfaced with a statistical analysis program that processed acanthosis nigricans and other obesity related data. Generated data is valuable for school districts as they design health promotion programs to address children's health issues.

School children in Texas have been screened for Acanthosis Nigricans (AN) as part of a healthy-child screening activity under the direction of the University of Texas-Pan American Border Health Office (UTPA BHO) since 1998. The AN screening program resulted from a legislative mandate. AN is characterized by hyperpigmentation and appears as a light brown-black, velvety, furrowed rough or thickened manifestation on the surface areas of the skin. It usually materializes on the nape of the neck but also appears on the knuckles, elbows, axillae, knees, abdomen, thighs and soles of the feet. (Schwartz, 1994). In most cases, the AN manifestations may appear like a dirty neck and can easily be evaluated by means of a visual examination. Hyperinsulinemia, a consequence of insulin resistance that is associated with obesity, stimulates the formation of these markers (Cruz & Hud, 1992; Davidson, 1995). Insulin resistance has also been noted in type 2 diabetes and a linked factor for cardiovascular diseases (Reaven, 1988; Laakso, 1996; Stuart, Gilkison, Keenan, & Nagamani, 1997; Stuart, Discoll, et al.1998). While AN can begin at any age, it is most frequently seen during preadolescence (Stuart, Gilkison, et al. 1998; Longshore et al., 2003). Figure 1 shows two examples of this condition.

Type 2 diabetes is often part of a metabolic syndrome that includes obesity, elevated blood pressure, and high levels of blood lipids. Its complications include diabetic coma, diabetic retinopathy, diabetic nephropathy, diabetic neuropathy, and peripheral vascular disease (Valabhji et al., 2003). Nearly 17 million people (6.2% of the population) have diabetes. This increases by almost 800,000 per year. Of this number, 11.1 million are diagnosed and 5.9 million are not. Diabetic retinopathy is a major cause of blindness in economically active adults worldwide (Valabhji et al., 2003). Type 2 diabetes undeniably poses major health burdens for individuals, families, and communities (Bastida, Cuellar & Villas, 2001; Gabbay, Cesarini, & Dib, 2003). African Americans, Native Americans and Hispanics bear a disproportionate burden of the diabetes population and the burden is only going to increase as a result of rapid population growth and the aging process. Diabetes is a disease that can be treated but can't be cured. The best way is to intervene before the disease becomes fact. Therefore, it is important to determine the onset of hyperinsulinemia and insulin resistance as early as possible.

Insulin resistance is a primary risk factor for type 2 diabetes and it has been reported that half of the people with type 2 diabetes have AN (Bloomgarden,

Paul Villas, D.Ed., CHES is affiliated with the Department of Health and Kinesiology at The University of Texas-Pan American. *Zhixiang Chen, Ph.D.* is affiliated with the Computing and Information Center at The University of Texas-Pan American. *Doreen Garza, MPH* and *David Salazar, MS* are affiliated with the Border Health Office at The University of Texas-Pan American. Address all correspondence to *Paul Villas, D.Ed., CHES*, Department of Health and Kinesiology, The University of Texas-Pan American, 1201 West University Drive, Edinburg, Texas 78541. PHONE: 956.318.8900; FAX: 956.381.3502; E-MAIL: pvillas@utpa.edu.

Figure 1: Acanthosis Nigricans: A Hyperinsulinemia Induced Condition

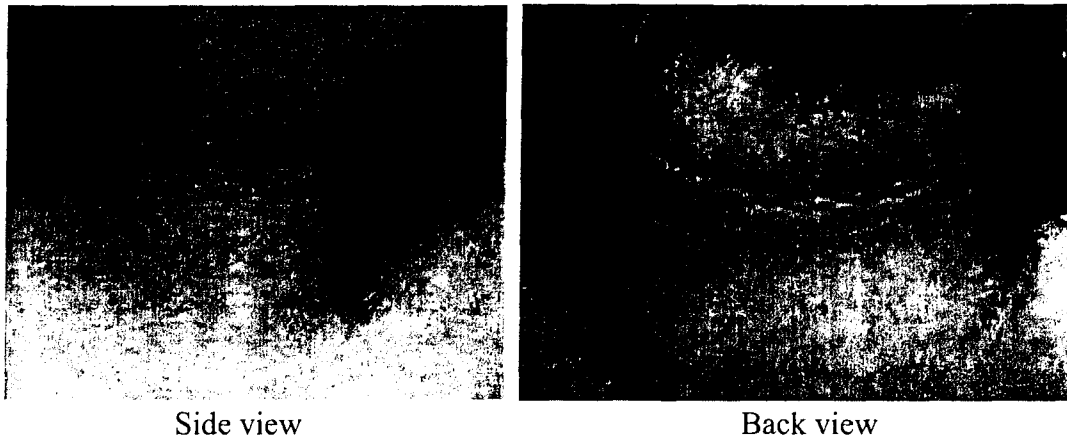Side view   Back view

Photo Courtesy: Charles Stuart, M.D.

2003). AN and obesity are listed as risk factors for type 2 diabetes (American Diabetes Association, 2000). About 80% of people with type 2 diabetes are overweight and as more children become overweight, type 2 diabetes has become more common among young people (Owen et al., 2003; Kaufman, 2003). This is why there is value in AN screenings since they provide a quick gauge of insulin resistance and identify children at risk of developing chronic diseases.

The regular monitoring and checking of AN is important because of the increasingly alarming rates of persons developing type 2 diabetes. Until recently, it was believed that children could not develop type 2 diabetes. However, we now know that children are not exempt (Owen et al., 2003; Kaufman, 2003). High insulin levels over long periods of time can increase the risk if the following conditions are present: obesity, cardiovascular problems, hypertension, and increased cholesterol and triglycerides (Stuart et al., 1998; Longshore et al., 2003; Uyttendaele et al., 2003; Rojas, Menchaca, & Wadley, 2004). AN screenings can help identify those who have high insulin levels and may be at risk for developing various diseases. Once identified, the necessary measures can be taken to lower the insulin levels and to reduce the risk of developing chronic diseases. Exercise and proper nutrition help the body become more sensitive to insulin and lower insulin levels, two components that are part of a comprehensive school health program. Obesity causes insulin resistance and weight loss can correct the problem. Insulin resistance improves quickly in response to improved diet and increased physical activity. Once students begin to lose weight, the AN

fades and so do the risks of long-term vascular complications (CDC Diabetes Cost-Effectiveness Study Group, 1999).

As part of the AN screening procedure, when school personnel determine a child has the AN marker, they also ascertain the child's body-mass-index (BMI) and blood pressure measurements. These data are reported to parents who in turn seek clinical professional assistance. Measurements are recorded on a form that can be kept in schools as part of the child's permanent file. School districts have been providing said data to the UTPA BHO on paper format for each elementary classroom in each school in the school district that is screened. The UTPA BHO was responsible for entering and analyzing data on approximately 300,000 children from over 300 school districts. The magnitude of the workload at the data-entry-point made it difficult for the UTPA BHO to respond to each school district with individualized district-particular information.

The replacement of a paper-based student health record with an electronic record was considered necessary to accommodate the large number of student records generated yearly by the Acanthosis Nigricans: The Education and Screening (ANTES) program. As a result, the UTPA BHO launched a method to establish a web-based electronic information system (EIS) that could respond to each school's needs promptly with analyzed summary reports. The desire was for the EIS to make a cumbersome and complicated school paper record more comprehensible and provide ready analysis of stored data for school district use. Structure in a system is paramount to accomplish these purposes

(Rector, Nowlan, & Kay, 1991; Moorman, 1994). A template was developed based on the already in place paper-based system in which users entered data according to a form developed by the UTPA BHO (Yamazaki, Satomura & Suzuki, 1995). Although a template-based data entry tends to limit what the user may enter, this impediment in our system was addressed by utilizing school nurses (users) in the development of the EIS. In this paper, we describe the design of the EIS, data structured by template and the capacity to provide instant analysis of data as a result of a structured data entry (Matsumura, Takeda, & Okada, 1997; Takeda & Matsumura, 1997).

METHOD

The UTPA BHO collaborated with the Computing and Information Technology Center on the UTPA campus to build a web-based electronic information system for the ANTES program. The system was designed for web browser applications to produce electronic forms that interface with a statistical analysis program. The information could conceivably be printed out on paper forms or compiled on a disk for storing or presenting the data.

We invited school nurses and other school health personnel to assist in the piloting of the EIS since they had been involved in assisting and providing ideas necessary to produce a system designed to utilize a web browser application that produced electronic forms. With the goal to make the system as uncomplicated and non-intimidating as possible, they came to the UTPA campus computer lab to enter data and then compute and summarize the data for a mock school district. This exercise proved useful in soliciting input from the main users of the EIS. The system users advised the UTPA BHO in template design methods and how to make the system work easily and efficiently.

The overriding objective of the program was to make the annual screening data submission as uncomplicated as possible for school personnel and still collect all the necessary data. In developing the program, we addressed concerns about confidentiality, integrity of the data submitted, and user friendliness. The paper system used by school nurses presented such challenges as inconsistency in AN screening reporting standards, a labor intensive data entry process, difficult localized data reporting due to the large number of students; and lack of capacity to report back to the school districts. With this in mind, we set out to build an electric system that addressed the said challenges and met the following objectives:

1. It must have a compatible information reporting electronic form the same as school personnel had in paper form.
2. It must maintain structural integrity among the UTPA BHO, school administrators, school personnel and relevant points and segments.
3. It should support comprehensive data management.
4. It must be compatible with any computer system used by school personnel to allow data transfer.
5. It must create a format for school districts to submit their data and allow for the establishing of a permanent record of the data as submitted.
6. It must facilitate data validation.
7. The data returned to school districts should be easily read by the school's comprehensive health team in order to structure programs which assist the students.

RESULTS

Using the ANTES Program Electronic Information System (EIS) ensured that data submitted on a specifically developed web template was consistent, timely, and original. The template had data cells for gender, grade, date of birth, body-mass-index (BMI), blood pressure measures, and grade of AN. Quality assurance features were built into each of the screens. At least four types of users are capable of accessing the system: the general public, school nurses/officials, school nurse coordinators and the administrators at the UTPA BHO. Since the general public sees aggregate descriptive information, entry into the web site is not controlled for this group. The general public is able to see summary information about AN, BMI and blood pressure by local district, region and the state. Since the other three users see more specific information, they need a user name and a user password to enter the EIA. School nurses learn about the AN, BMI, and blood pressure particulars in their own school; nurse coordinators learn about their school district; and the UTPA BHO administrators learn about all the school districts using the EIS. The users with passwords are also able to generate descriptive statistics to display data for their school administrators.

If a nurse or nurse coordinator user enters data in an incorrect cell or misses a cell, an error message appears and the incorrect value will not be accepted. Each screen includes a help link that will take the user to instructions for completing the form. Screens also include a link that shows the user a preview of a printed version of that form. The EIS has been configured to calculate percentile BMI and blood pressures as normal, high normal or elevated. The screening related data is submitted as soon as it is entered. The user can return to the opening page and click on "print" to

make a copy of the screen. This feature will automatically take the user to a new screen with a duplicate of the CDC growth chart and calculated and plotted BMI. These calculations are determined from the Centers for Disease Control and Prevention and from the National Institute of Heart, Lung and Blood. The printed growth chart with plotted BMI at a particular percentile can be sent to the family to present to a clinician as well as preserved in the student's school file. At any time, school personnel can print the summary pages associated with an individual student or the entire class. The EIS also allows school nurses to print referral forms that include the previously mentioned variables.

Through the course of a few months, we have improved the program by adding or modifying features. The latest version can analyze the information submitted and, in turn, the UTPA BHO can develop summary reports about the screening program.

DISCUSSION

We worked together to build an electronic student health record system that included various fields associated with risk factors for chronic disease. We made a template that accommodates gender, grade, date of birth, BMI, blood pressure measures, and grades of AN displayed as physical and demographical findings. As for the record of entered data, it was useful to the individual school districts to make decisions about students at risk for chronic health disease; the data was useful for designing health behaviors changing programs; and for the UTPA BHO, the information was useful for generating reports about the extent and types of health risk factors that existed in school children. Compared to the paper system of reporting consolidated screening information, the EIS is easier and more relevant to the individual school district. They get analysis on the information submitted instantaneously. The EIS is also much better for the UTPA BHO because the system allows the administrator to learn which schools and which nurses have or have not yet entered their data. Sometimes, an e-mail reminder is used to get the information uploaded. Additionally, the analysis capability of the system makes it possible to serve as many school districts as are currently screening and provide timely reports for each district.

The program has been well received by the main users – school nurses. Additionally, other partners such as health educators, physical educators and clinicians see potential and future application. Over the months since we started, we have seen an increase in the number of training sessions we were conducting on the EIS as well as the number of users being trained. This trend is expected to continue for at least two more years and then level off. An evaluation of the information presented on the EIS revealed the data matched field reports of actual students whose information was entered in the EIS.

The ANTES EIS is an innovative solution that completely automated the annual reporting of AN screening data by school personnel. The EIS is a point-to-point structure that is practical and user-friendly. It was developed at no cost to the users and requires minimal ongoing maintenance costs. It has many built-in quality assurance features and the data are easily accessible by users from school districts and by administrators at the UTPA BHO.

In summary, the EIS was developed on the template-based data entry system to make the reporting of AN related information easier, quicker, and more complete with capacity to interface with a statistical analysis program. Hierarchical structures of describing elements are accommodated with the template application. Using EIS, data entry was faster than handwriting and data presentation was evaluated superior to that of existing paper-based student records. Finally, AN should never be casually dismissed. The presence of AN indicated to the school health team that there was a serious biochemical disorder that required intervention. Usually, the recommended intervention for students and their families was to make necessary changes in diet and exercise.

REFERENCES

American Diabetes Association. (2000). Type 2 diabetes in children and adolescents. *Pediatrics, 105* (3).

Bastida, E., Cuellar, I., & Villas, P. (2001). Prevalence of diabetes mellitus and related conditions in a south Texas Mexican American sample. *Journal of Community Health Nurse, 18*(2), 75-83.

Bloomgarden, Z. T. (2003). Diabetes issues in women and children. *Diabetes Care, 26.*

CDC Diabetes Cost-Effectiveness Study Group, Centers for Disease Control and Prevention (1999). The cost-effectiveness of screening for type 2 diabetes. *Journal of National Medical Association, 281*(4), 325

Cruz P. D. Jr, Hud J. A. (1992). Excess insulin binding to insulin-like growth factor receptors: proposed mechanism for acanthosis nigricans. *Journal of Investigative Dermatology, 98*(6 Suppl), 82S-85S.

Davidson M. B. (1995). Clinical implications of insulin resistance syndromes [see comments] *American Journal of Medicine, 99*(4), 420-6.

Gabbay, M., Cesarini, P. R., & Dib, S. A. (2003). Type 2 diabetes in children and adolescents: Literature review. *Jornal de Pediatria (Rio J)*, *79*(3), 201-208.

Kaufman, F. R. (2003). Type 2 rising: Our young at risk. *Diabetes Forecast, 56*.

Laakso M. (1996). Insulin resistance and coronary heart disease. *Current Opinion in Lipidology, Aug, 7*(4), 217-26.

Longshore, S. J., Taylor, J. S., Kennedy A., & Nurko, S. (2003). Malignant acanthosis nigricans and endometrioid adenocarcinoma of the parametrium: The search for malignancy. *Journal of the American Academy of Dermatology, 49*(3), 541-3.

Matsumura Y., Takeda H., Okada T. (1997) Method of structured Data Entry in Electronic Patient Record. *Japanese Journal of Medical Information, 17*(3 Suppl), 193-201.

Moorman P. W., Van Ginneken A. M., Van Del Lei J, & Van Bemmel J. H. (1994). A model for structured data entry based on explicit descriptional knowledge. *Methods of Information Medicine, 33*, 454-63.

Owen, K. R., Stride, A., Ellard, S., & Hattersley, A.T. (2003). Etiological investigation of diabetes in young adults presenting with apparent Type 2 diabetes. *Diabetes Care, 26*.

Takeda H., Matsumura Y. (1997). Dynamic template driven data entry system for an EPR system. Proceedings of: Toward an Electronic Patient Record '97, (pp. 139-147). Nashville Broadview: Kelvyn Press.

Schwartz R. A. (1994). Acanthosis nigricans. *Journal of the American Academy of Dermatology, 31*(1):1-19.

Stuart, C. A., Discoll, M. S., Kurt, L. F., Gilkison, C. R., Sudah, S., & Smith, M. M. (1998). Acanthosis nigricans. *Journal of Basic and Clinical Physiology and Pharmacology, 9*(2-4), 407-418.

Stuart C. A., Gilkison C. R., Keenan B. S., & Nagamani M. (1997). Hyperinsulinemia and acanthosis nigricans in African Americans [see comments] *Journal of National Medical Association, 89*(8), 523-7.

Stuart, C. A, Gilkison, C. R, Smith, M. M, Bosma, A. M, Keenan, B. S, & Nagamani, M. (1998). Acanthosis nigricans as a risk factor for non-insulin dependent diabetes mellitus. *Clinical Pediatrics, 37*(2), 73-9.

Reaven, G. M. (1988). Role of insulin resistance in human diseases. *Diabetes*, 37, 1595-1607.

Rector A. l., Nowlan W. A., & Kay S. (1991). Foundations for an electronic medical record. *Methods of Information Medicine, 30*, 179-86.

Rojas X., Menchaca J., & Wadley W. (2004). Cardiovascular risk factors in Mexican-American children at risk for type 2 diabetes mellitus (t2dm). *Journal of Adolescent Health, 34*, 290-299.

Uyttendaele H., Koss, T., Bagheri, B., Schneiderman, P., Silfen, M., Gallagher, M., Garzon, M., & Engler, D. (2003). Generalized acanthosis nigricans in an otherwise healthy young child. *Pediatric Dermatology, 20* (3),

Valabhji, J., Watson, M., Cox, J., Poulter, C., Elwig, C., & Elkeles, R.S. (2003). Type 2 diabetes presenting as diabetic ketoacidosis in adolescence. *Diabetic Medicine, 20* (5)

Yamazaki S, Satomura Y, & Suzuki T. (1995) The concept of "Template" assisted electronic medical record". *Proceeding of Medical Information*: [Medinfo] 8 Part 1, 249-52.

CHES AREAS

Responsibility IV - Evaluating Effectiveness of Health Education Programs

Competency C -Interpret results of program evaluation.

Sub-competency 3 - Report effectiveness of educational programs in achieving proposed objectives.