Evaluating and Implementing Change in Follow-up
S. Denniston, Oregon State Public Health Laboratory, Hillsboro, OR

Abstract

In relation to reassessing business as usual: I came into the newborn screening program with fresh eyes, this opened the doors for unbiased evaluations on processes and changes that needed to be made. My presentation will start with a brief overview of the Oregon State Public Health lab and the Regional Program we support, leading to my experience over the first year as the Follow Up Coordinator. This will focus on three main points: Correspondence edits, streamlining, and information system updates. Correspondence: most of the educational and follow up letters for providers were created in 2002 with some edits in 2006. This was when MS/MS first started in Oregon and later CAH and IRT were added. The materials were cumbersome and burdened with paragraphs of unnecessary information. The goal was to simplify, make bold headlines and “Action Needed” lists for providers to easily digest the information. I will show examples on slides of changes and present total # of updates including deletion of many different pieces that are significant cost reductions and streamlines processes.

Streamlining: Reducing postage costs and office waste. Elimination of redundant processes such as scanning, faxing, and making copies of the same information. Moving away from multiple excel spreadsheets. I will talk about some of the unique changes to our program in regards to Alaska CPT1A variant babies. The goal: reduction in follow up completion timelines.

Information systems: Full utilization of IS capabilities have been implemented in the database. Modifications of reporting functions allows for better data collection and historical accuracy. I will present the additions to the database and changes to the structure of reporting functions on confirmed cases.

In summary the amount of change has been difficult but staff has pulled together to support the implementation and improvements. The office is now ready to take on SCID for a 2014 start date while continuing to make changes as we move forward.

Presenter: Sara Denniston, BS, Oregon State Public Health Laboratory, Newborn Screening, Hillsboro, OR, Phone: 503.693.4173, Email: sara.denniston@state.or.us
**Summary**

I was hired as the newborn screening follow-up coordinator in April 2013. I was already an internal state employee but I had little knowledge of newborn screening. The goals for once I was comfortable in follow up in were:
- Correspondence edits
- Completed database capabilities
- Streamline inner office processes to reduce wasted time and materials

I was lucky to be trained by Judi Tuerk, whom the new Follow-Up award being presented this year is named after. Many of the changes made are not specific to newborn screening processes but are just general business practices that should be evaluated and updated over time. While the Oregon lab had an established and well run follow up-program, it had not been reviewed by an outsider in many years. This presentation will go over some of the changes I made in the office since I have started. I am fortunate to have some free reign over the office and my manager is pretty hands off so as I have continued to get more comfortable and understand newborn screening I keep finding more things to change.

Examples of several edits to various letters and fax notifications used in short term follow-up will be presented. Comparisons of before and after edits will be shown to provide ideas for other programs on how to simplify their documents if they are in the process of doing similar changes.

The database the Oregon lab uses is Neometrics. Several pieces of the case management system were not being utilized because the development was not completed by lab staff. Processes that have been completed will be highlighted and screenshots shown to provide clear explanation of improvements. Report functions have been added and pieces of the database system have been activated, such as the fax result option and diagnosis screens.

Inner office processes will be highlighted that have reduced staff time and material resources being used. Oregon screens for Alaska and there is a special population we track for a condition called CPT1A Arctic Variant. The documentation and tracking of these cases has been streamlined. Several other improvements in the office involving faxing, scanning, and mailing have been updated reducing paper waste and turnaround times of follow up activities. Examples will be presented that were based off LEAN training and mapping of processes to cut out unnecessary steps.

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**The Controversy on Mild (Compensated) Congenital Hypothyroidism – The Path We Took to Resolve the Dilemma in Washington Newborn Screening**

C. Nucup-Villaruz\(^1\), P. Fechner\(^2\); \(^1\)Washington State Department of Health, Shoreline, WA; \(^2\)Seattle Children’s Hospital, Seattle, WA

**Abstract**

**Objective:** Review data of the newborn screening primary TSH values and serum thyroid studies of confirmed mild congenital hypothyroidism (CH) and false positive cases, as well as age at diagnosis and treatment of confirmed mild CH cases. Present the issues and dilemma of either confirming or ruling
out the diagnosis of CH based on the serum thyroid results. Determine the appropriate TSH threshold at a certain age that merits further monitoring and follow-up.

**Methods:** Primary TSH data from confirmed CH and false positive cases in 2012 were collected and analyzed. Classification and diagnosis of CH was based on the serum TSH levels. This set of data was initially presented to the Pediatric Endocrinology Association for Research Learning (PEARL) conference on March 8, 2014 in Portland, Oregon to seek guidance from endocrinologists regarding appropriate follow-up for mild CH. A comparison of reference ranges from different diagnostic laboratories used by endocrinologists and primary care providers in Washington State was also included in the presentation.

**Results/Discussion:** We reviewed the TSH values of confirmed mild CH cases versus false positive cases ruled out by endocrinologists and primary care providers. A snapshot demonstrated by a superimposed scatter plot showed a clear overlapping of TSH values used by endocrinologists or primary care providers to confirm or rule out the diagnosis of congenital hypothyroidism. We also reviewed several journal articles explaining the pros and cons of treating or not treating mild or compensated hypothyroidism.

**Conclusion:** After presenting the mild CH data and further discussion, an implied consensus among pediatric endocrinologists within the Pacific Northwest region was reached during the PEARL conference in Portland, Oregon. A serum TSH level of equal to or greater than 6.0 µIU/ml drawn between 14-30 days of age would require either repeat thyroid function tests or a referral to a pediatric endocrinologist. Our referral memo has been modified to reflect this recommendation based on the consensus of pediatric endocrinologists in the Pacific Northwest region.

**Presenter:** Patricia Fechner, MD, Seattle Children’s Hospital, Division of Endocrinology, Seattle, WA, Email: patricia.fechner@seattlechildrens.org or caroline.nucup-villaruz@doh.wa.gov

**Summary**

**Background:** The prevalence of congenital hypothyroidism (CH) has increased not only in the US but also worldwide. CH screening in Washington State began in 1977 using radio-immunoassay (RIA) with primary thyroxine (T4) reflexing to thyroid stimulating hormone (TSH) for the lowest 10% of daily T4 values. We switched to primary TSH in 2004. Reference ranges or cut-offs have been adjusted periodically to catch borderline and presumptive cases in a concerted effort to reduce false negative results. Since 2004, we have noted a significant increase in the number of mild CH cases particularly “compensated or subclinical types of hypothyroidism.” Compensated or subclinical hypothyroidism is defined as serum TSH that is above the upper limit of normal range but total or free T4 is within normal range. We have also noticed the discrepancy on the process of confirming or ruling out CH based on serum thyroid results. As a newborn screening program, this has been a dilemma for us because we rely on the guidance of pediatric endocrinologists to validate the final diagnosis. Compounding the issue was the fact that there was no universal consensus among endocrinologists regarding appropriate management of mild CH due to different laboratory reference ranges used by physicians in general. Taking all these into account, we presented 2012 TSH data set to a group of pediatric endocrinologists in the Pacific northwest in the hope of obtaining a consensus and guidance on the appropriate follow-up and resolution of these cases.

**Methodology:** To accomplish our objectives, we did the following: (1) reviewed the 2012 TSH positive cases referred for diagnostic serum thyroid studies; (2) presented several sets of reference ranges used by different laboratories in Washington State; (3) cited and reviewed available literature to either support or oppose the contention of further follow-up either by monitoring thyroid levels or starting treatment with levothyroxine; (4) presented all of the above along with our data at the 2014 Pediatric Proceedings of the 2014 APHL Newborn Screening and Genetic Testing Symposium, Anaheim, CA, October 27-30, 2014
Endocrinology Association for Research and Learning (PEARL) conference held at Portland, Oregon on March 8, 2014.

Discussion:

Table 1 - “Normal” TSH (mIU/L) Ranges used by reference laboratories

<table>
<thead>
<tr>
<th>Laboratories (reference labs in Washington State)</th>
<th>0 – 7 days</th>
<th>7 days – 1 month</th>
<th>1 – 3 months</th>
<th>3 – 11 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esoterix (ICMA)</td>
<td>1.3 - 16</td>
<td>0.9 – 7.7</td>
<td>0.9 – 7.7</td>
<td></td>
</tr>
<tr>
<td>Quest</td>
<td>0.7 – 15.4</td>
<td>1.7 – 9.1</td>
<td>0.8 – 8.2</td>
<td>0.8 – 8.2</td>
</tr>
<tr>
<td>P A M L (ICMA)</td>
<td>0.52 – 16.0 M 0.72 – 13.1 F</td>
<td>0.52 – 16.0 M 0.72 – 13.1 F</td>
<td>0.55 – 7.1 M 0.46 – 8.1 F</td>
<td>0.55 – 7.1 M 0.46 – 8.1 F</td>
</tr>
<tr>
<td>S C H (chemiluent)</td>
<td>1 – 20 (0-3 days) 0.5 – 6.5 (10 is critical)</td>
<td>0.5 – 6.0</td>
<td>0.5 – 6.0 ≤ 5m 0.5 – 4.5 ≥ 5m</td>
<td></td>
</tr>
<tr>
<td>O H S U</td>
<td>0.7 - 18.1</td>
<td>0.7 - 18.1</td>
<td>1.2 – 8.21</td>
<td>1.2 – 8.21</td>
</tr>
</tbody>
</table>

Table 2 - TSH Reference Range (Lem et al. JCEM 2012, 97:3170-3178)

<table>
<thead>
<tr>
<th>AGE</th>
<th>-2 SDS</th>
<th>-1SDS</th>
<th>0</th>
<th>1 SDS</th>
<th>2 SDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>2.43</td>
<td>3.84</td>
<td>6.44</td>
<td>11.75</td>
<td>24.03</td>
</tr>
<tr>
<td>1 day</td>
<td>1.90</td>
<td>3.21</td>
<td>5.44</td>
<td>9.76</td>
<td>17.58</td>
</tr>
<tr>
<td>2 days</td>
<td>1.40</td>
<td>3.21</td>
<td>5.44</td>
<td>9.76</td>
<td>17.58</td>
</tr>
<tr>
<td>3 days</td>
<td>0.94</td>
<td>2.03</td>
<td>3.75</td>
<td>6.24</td>
<td>9.65</td>
</tr>
<tr>
<td>4 days</td>
<td>0.60</td>
<td>1.48</td>
<td>2.85</td>
<td>4.64</td>
<td>6.82</td>
</tr>
<tr>
<td>1 week</td>
<td>0.58</td>
<td>1.18</td>
<td>2.14</td>
<td>3.57</td>
<td>5.58</td>
</tr>
<tr>
<td>1 month</td>
<td>0.58</td>
<td>1.18</td>
<td>2.14</td>
<td>3.57</td>
<td>5.57</td>
</tr>
<tr>
<td>3 months</td>
<td>0.58</td>
<td>1.18</td>
<td>2.14</td>
<td>3.57</td>
<td>5.57</td>
</tr>
<tr>
<td>6 months</td>
<td>0.58</td>
<td>1.18</td>
<td>2.14</td>
<td>3.56</td>
<td>5.56</td>
</tr>
<tr>
<td>1 year</td>
<td>0.57</td>
<td>1.17</td>
<td>2.13</td>
<td>3.55</td>
<td>5.64</td>
</tr>
</tbody>
</table>
Figure 1 - Scatter Plot of Washington NBS - 2012 TSH values

Figure 2 – Recommendations for management of neonates with borderline thyroid function
Primary care providers and even endocrinologists use different laboratories that use different reference ranges (see Table 1). Based on normal reference ranges (see Table 2) reported by Lem in 2012, TSH should not exceed 6.0 by 7 days of age or older. To illustrate the discrepancy between true positive and false positive cases that were referred to undergo thyroid function tests, we superimposed the serum TSH values of patients on a scatter plot (see Figure 1). Based on this chart, there was clear overlap of the true cases and false positive cases. This brings us to conclude that endocrinologists have differing opinions regarding follow-up or management of mild CH. These results supported our hypothesis that there is no universal consensus among pediatric endocrinologists in Washington State, regarding confirmation or ruling out of mild or compensated hypothyroidism. Based on available literature that we have reviewed (see list of references), six authors (1,2,3,4,5,6) favor treatment and follow-up, two authors (7,8) will treat patients depending on other factors and the last two authors (9,10) will not treat patients. So majority of these authors especially leading experts like Drs. LaFranchi and Leger believe and practice treating patients with mild or subclinical hypothyroidism, both papers were just published and released this year (2014). In particular, Dr. LaFranchi’s paper showed recommended algorithm (see Figure 2) regarding appropriate management of these cases.

**Conclusions:** Endocrinologists differ in regards to follow-up and management of mild CH based on our 2012 TSH data. However, more endocrinologists favor monitoring, follow-up and and treating patients with mild CH based on available and current literature review. A consensus was reached during the 2014 PEARL conference on March 8, 2014 led by Dr. Fechner and Dr. LaFranchi that a serum TSH equal to greater than 6.0 at two weeks of age or older will need repeat serum thyroid studies or a referral to a pediatric endocrinologist. Our TSH protocol and memo were modified based on this consensus and recommendation.

**Future Directions:** As a screening program, we suggest and encourage more studies on pediatric mild CH to compare the outcome of (a) short-term vs. long-term follow-up; (b) early vs. late treatment; (c) with or without treatment and (d) benefits and adverse effects of treatment. We also suggest a unification or consensus of clinical practice guidelines, reference ranges and definitions the following terms: mild congenital hypothyroidism, compensated hypothyroidism and transient hypothyroidism. As newborn screeners, we would like to reiterate that our goal does not stop in the early detection of CH but also making sure that prompt and adequate treatment is rendered, as well as appropriate long-term follow-up to ensure and achieve the best neuro-developmental outcomes close to these patients’ genetic potential. This is the true essence of thyroid screening and one of the vital keys to a successful newborn screening program.

**Reference**

- Tenenbaum- Rakover Y. Approach to Subclinical Hypothyroidism in Children. Intech 2013..

Feasibility of Providing Long-Term Care and Follow-Up for Patients with Congenital Hypothyroidism by Primary Care Providers in California and Hawaii

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Abstract

Introduction: Primary Congenital Hypothyroidism (PCH) is the most common disorder screened for by the Newborn Screening Programs (NBSPs) in California and Hawaii. Without early detection and prompt treatment, PCH can cause severe mental retardation. The majority of PCH patients require lifelong treatment. Little is known about how children with PCH are being managed and the feasibility of providing long-term care and follow-up (LTFU) by primary care providers (PCPs). This study assesses the feasibility for PCPs in California and Hawaii to provide LTFU to patients with PCH.

Methods: A cross-sectional survey was conducted among 822 physicians who were listed as the contact doctor of at least one confirmed PCH patient identified through the NBSPs in California (n=800) and Hawaii (n=22) during Jan 1, 2009–Dec 31, 2013. Information on number of current PCH patients, willingness and barriers to provide LTFU, and reasons for not being able to provide LTFU was collected. Analysis was done for both states together.

Results: By Apr 28, 2014, we have received 176 completed surveys from PCPs. Among which, 78% currently have at least one patient with PCH and 90% indicated that they are willing to provide PCH-related long-term care to new patients. For familiarity with PCH treatment guidelines, only 5% indicated very familiar and 63% somewhat familiar. Regarding providing LTFU data to national databases, 74% of physicians indicated willingness to obtain informed consent from patients and 84% are willing to provide data to the LTFU database if patients grant permission. In terms of compensation required for LTFU data collection, 22% indicated that no compensation is needed, 28% indicated $100 per patient per year or under, 39% indicated $150 or $200, and 11% indicated other amount. Among those who are unwilling to
provide data to the LTFU database, 41% indicated “not having enough staff or time” as a reason, 37% do not provide long term care to patients with PCH, and 18% have concerns over patient’s privacy.

**Conclusions:** Our data showed that the majority of PCPs completing the survey are willing to provide long-term care and follow-up to their patients with PCH. It is feasible to collect LTFU data from PCPs.

**Presenter:** Ning Rosenthal, MD, PhD, California Department of Public Health, Genetic Disease Screening Program, Richmond, CA, Phone: 510.412.1522, Email: ning.rosenthal@cdph.ca.gov

**Summary**

**Background and Objective:** Primary Congenital Hypothyroidism (PCH) is the most common disorder screened for by the Newborn Screening Programs (NBSPs) in California and Hawaii. Without early detection and prompt treatment, PCH can cause severe mental retardation. The majority of PCH patients require lifelong treatment. Little is known about how children with PCH are being managed and the feasibility of providing long-term care and follow-up (LTFU) by primary care providers (PCPs). The objective of this study is to assess whether it is feasible for PCPs in California and Hawaii to provide LTFU to patients with PCH.

**Methods:** A cross-sectional survey was conducted among 823 physicians who were listed as the contact doctor of at least one confirmed PCH patient identified through the NBSPs in California (n=801) and Hawaii (n=22) during January 1st, 2009–December 31st, 2013. Both paper and online surveys were used for data collection. Information on number of current PCH patients, willingness and potential barriers to provide LTFU, and reasons for not being able to provide LTFU was collected. Analysis was done for both states together.

**Results:** Characteristics of survey respondents: A total of 206 PCPs completed the survey. Of which, 51% were male, 7.1% were of Hispanic origin, 46% were White, and 38% were Asian. Over 45% of respondents reported having private practice, 33% were in group practice, 4% were in hospital-based practice, 4% were in HMO, and 13% practiced in community health centers. In terms of medical specialty, 92% specialized in general pediatrics, 8% specialized in family practice and 3% specialized in other specialties. The median of years in medical practice was 18 years with a range of two to 43 years. Current management pattern and willingness to provide long-term care: Of all respondents, 79% reported having at least one patient with PCH at the time of data collection. When being asked “who usually manages the patient’s PCH conditions”, 18% of PCPs said that their patients were mainly managed by themselves but endocrinologists were involved; 63% reported that their patients were mainly managed by endocrinologists but they are also involved; and 19% reported that their patients were solely managed by endocrinologists. Nearly 91% of responding PCPs indicated that they were willing to provide PCH-related long-term care to new patients. For perceived barriers for providing long-term care for patients with PCH, 61% of PCPs reported needing guidance or support from endocrinologists and 28% indicated unfamiliarity with PCH treatment guidelines as a barrier. About 20% of respondents anticipated no barrier to provide long-term care.

Care coordination: Among all responding PCPs, 94% reported knowing a pediatric endocrinologist with whom they may consult for PCH-related questions. In terms of difficulties encountered when coordinating care with pediatric endocrinologists for patients with PCH, 65% indicated no difficulty, 30%
indicated that “some endocrinologists are hard to reach” and 5% could not find any endocrinologists to work with in their area.

Willingness to collect LTFU data and perceived barriers: Over 76% of PCPs indicated willingness to obtain informed consent from patients and 84% were willing to provide data to the LTFU database if patients grant permission. Among those who were willing to provide LTFU data, 35% prefer web-based forms, 36% prefer paper forms and 22% had no preference. In terms of compensation required for LTFU data collection, 24% indicated that no compensation is needed, 29% indicated $100 per patient per year or under, 37% indicated $150 or $200, and 11% indicated other amount. Among the 27 respondents who were not willing to provide data to the LTFU database, 37% indicated “not having enough staff or time” as a reason, 37% do not provide long term care to patients with PCH, and 18% have concerns over patient’s privacy.

Familiarity with PCH-related treatment guidelines: Only 4% of respondents indicated very familiar and 66% indicated somewhat familiar with PCH-related treatment guidelines. Only 49% of PCPs correctly answered the recommended frequency of blood tests to monitor patients with PCH for three age groups including “less than 6 months”, “6 months to 3 years”, and “over 3 years” of age. Specifically, only 2% of respondents were very familiar with diagnostic indications for transient congenital hypothyroidism, 28% were somewhat familiar and 55% not familiar at all. Only 23% of respondents knew the appropriate age to try eligible patients off the levothyroxine treatment to rule out transient congenital hypothyroidism.

Conclusions: Our data showed that the majority of PCPs completing the survey are willing to provide long-term care and follow-up to their patients with PCH. It is feasible to collect LTFU data from PCPs. There is a general lack of knowledge about PCH treatment and management among responding PCPs.

Reducing Time from Referral to Treatment: Strengthening the Weak Links in the Newborn Screening Chain of Events
A. Kimura, S. Weiss and J. Thompson, Washington State Department of Health, Shoreline, WA

Abstract

Background: The time between a newborn screening referral and the first clinic visit is a critical period in ensuring a rapid clinical response. Early diagnosis of cystic fibrosis (CF) in particular can lead to better nutrition and healthier lives for affected patients.

Objective: To describe a process of improving short-term follow-up from time of referral to time of first clinic visit.

Methods: Discussion with our pulmonology program consultants during a periodic review of the CF algorithm, in conjunction with anecdotal evidence, prompted more detailed investigation into our program performance. We analyzed data on critical junctures in CF short-term follow-up from January 2011 to December 2013 and compared performances among each CF center in Washington State. We presented the data to our consultants in March 2014, and we are in the process of developing and implementing changes to follow-up.

Results: Our analysis uncovered the following areas of improvement: 1) time from newborn screening referral to first sweat test, 2) time from an inconclusive sweat test to a repeat sweat test, and 3) time from positive sweat test to first clinic visit. One protocol instituted as a result of our analysis is to test for...
ΔF508, the most common CF-causing mutation, in our laboratory if a newborn’s first sweat test result is inconclusive. We will discuss this protocol and other changes that have been made to our follow-up procedures.

**Conclusions:** Time from referral to a child’s first clinic visit is a crucial period of short-term follow-up that has not been studied in depth. The consistent surveillance and tracking of abnormal results and strong relationships with clinical consultants at specialty care centers have provided us with a solid foundation to evaluate and improve upon our follow-up protocols.

**Presenter:** Amanda Kimura, MPH, Newborn Screening, Washington State Department of Health, Shoreline, WA, Phone: 206.418.5523, Email: amanda.kimura@doh.wa.gov

**Summary**

The time between a newborn screening referral and treatment is a critical period in ensuring a rapid clinical response. Early diagnosis of cystic fibrosis (CF) in particular can lead to better nutrition and healthier lives for affected patients. I will describe how the Washington State Newborn Screening (NBS) program has strengthened weak links in our program’s follow-up, using time from referral to first clinic visit for CF as a case study.

Washington uses an IRT/IRT algorithm that we have modified over the years due to consistent surveillance of abnormal results and discussions with our program consultants. Our lab can test in-house for the most common CF-causing mutation, F508del, under special circumstances to expedite diagnosis. We test for F508del if a newborn had persistently elevated IRT and is unable to undergo a sweat test due to low birthweight or unstable clinical status. We also test for F508del if the family or primary care provider (PCP) is non-compliant and the IRT is above 150 ng/mL on the first screen or persistently elevated.

When we detect persistently elevated IRT, we first recommend sweat testing to the PCP via phone and fax a referral memo, requisition form, sweat labs’ contact information, and educational material on CF. The PCP notifies the family and orders the sweat test. The PCP or family may schedule the sweat test. Once the sweat test is completed, the sweat lab reports results to us and the PCP. If sweat results are positive, the lab also contacts the CF clinic, who schedules an appointment with the family. Our goal is to have the sweat test done within one to two days after our referral and the clinic visit scheduled within one day after the sweat test.

We maintain two Excel spreadsheets that provide a valuable source of data for analysis. One spreadsheet helps us monitor day-to-day follow-up by tracking newborns with at least one abnormal IRT result. We record date of birth, birthweight, race, sex, whether they were in the neonatal intensive care unit (NICU), IRT value, and age at collection. If we refer an infant for a sweat test, we also monitor the location of the sweat lab, date of referral, date of resolution, and any "quantity not sufficient" (QNS) results. The second spreadsheet monitors all diagnosed CF cases. Besides data from the abnormal results spreadsheet, we also record sweat chloride value, date of diagnosis, date of first clinic visit, genotype, pancreatic status, meconium ileus, and the patient's CF center.

These tracking spreadsheets have helped in reviews of our CF NBS algorithm for periodic meetings with our CF program consultants. In January 2014, we reviewed data on the 19 infants who were diagnosed with CF.
with CF over two years (2012-13). We reported median days for these babies at the following key points during the NBS process: age at report of the first abnormal IRT, age at collection of the second newborn screen, age at referral for sweat testing, age at sweat test, and age at first clinic visit. What caused concern were gaps between the age at referral and age at sweat test and age at first clinic visit. On average, sweat tests were performed five days after we recommended sweat testing and first clinic visits scheduled four days after the sweat test – far from our goal of within two days and one day, respectively. Our consultants and NBS staff agreed that this needed to be studied further.

We conducted a retrospective secondary data analysis, looking at the distribution of days from referral to first sweat test, regardless of sweat test result. Our study sample included all non-NICU infants requiring sweat testing over three years (2011-13), which totaled 86 infants. We stratified data by the three CF centers in our state.

We looked at the distribution of non-NICU newborns referred by interval time between referral and first sweat test (Table 1). The two takeaways are that 1) overall it is taking too long for babies to be sweat tested and 2) the timeliness of sweat testing depends on the CF centers’ sweat labs.

Table 1. Distribution of non-NICU newborns referred for SwCl by interval time between referral and 1st SwCl

<table>
<thead>
<tr>
<th></th>
<th>1-2 days</th>
<th>3-7 days</th>
<th>8-14 days</th>
<th>15-30 days</th>
<th>31+ days</th>
</tr>
</thead>
<tbody>
<tr>
<td>WA CF Centers (n=86)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF Center 1 (n=52)</td>
<td>15 (29%)</td>
<td>20 (38%)</td>
<td>13 (25%)</td>
<td>3 (6%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>CF Center 2 (n=21)</td>
<td>11 (52%)</td>
<td>7 (33%)</td>
<td>3 (15%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CF Center 3 (n=13)</td>
<td>4 (31%)</td>
<td>1 (7%)</td>
<td>4 (31%)</td>
<td>4 (31%)</td>
<td>0</td>
</tr>
</tbody>
</table>

We also calculated the median value for days from referral to first sweat test, days from positive sweat test to first clinic visit, and days from referral to resolution (Table 2). Again, we see that the average amount of time from referral to treatment and first clinic visit is much longer than recommended time frame and that the average time varies depending on location.

Table 2. Timeline for non-NICU newborns referred for SwCl – Median Days (n=86)

<table>
<thead>
<tr>
<th></th>
<th>WA CF Centers</th>
<th>CF Center 1</th>
<th>CF Center 2</th>
<th>CF Center 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days from referral to 1st SwCl</td>
<td>4 (n=86)</td>
<td>4.5 (n=52)</td>
<td>2 (n=21)</td>
<td>12 [range 1-25] (n=13)</td>
</tr>
<tr>
<td>Days from positive SwCl to 1st clinic visit</td>
<td>3 (n=25)</td>
<td>3 (n=17)</td>
<td>4 (n=6)</td>
<td>1.5 (n=2)</td>
</tr>
<tr>
<td>Days from referral to resolution*</td>
<td>5 (n=85)</td>
<td>5 (n=52)</td>
<td>3 (n=21)</td>
<td>10 [range 1-194] (n=12)</td>
</tr>
</tbody>
</table>

*1 case is pending.
We also analyzed the QNS results that occurred during the same time period. Important findings from this analysis are:
- 10% (n=12) of infants sweat tested had at least one QNS result.
- 50% of babies with a QNS result ended up being diagnosed with CF, all through DNA.
- All true positive cases with QNS results had at least one copy of F508del.

The median time between the first QNS result and the first repeat sweat test was 24 days. We presented our findings to our program consultants, who include the Washington state CF Center director, in March 2014. He forwarded the four-page summary we sent him of our findings to the CF centers. Since then, the CF centers have implemented changes and will be collaborating with each other to improve their follow-up. CF Center 1 uncovered an influx of new nurses and laboratory staff who were under-educated about sweat testing, particularly that sweat tests can be performed on babies in the first weeks of live. They are currently educating these staff members. CF Center 3 uncovered that schedulers had been offering appointments two to three weeks out. They are currently modifying their processes so next day appointments will be offered. Sweat labs from 1 and 3 will be in contact to discuss collection methods to help improve 3’s QNS rates. We also intend to have CF Center 2 share with other CF centers helpful practices in ensuring a timely sweat test.

We have also recognized ways we can improve our processes. We have tightened our follow-up actions for referrals. In response to the QNS data, we now test for F508del immediately after a QNS result is reported to us. Furthermore, newborn screening staff and consultants have noted a lack of education on sweat tests among health care providers, particularly on the age that a sweat test can be performed. We will now include information about this concern in our referral memo to emphasize that sweat tests can be performed early on newborns.

The next step is to evaluate our efforts since the time we reported the findings to our program consultants. Since the results have been passed on to the CF centers, we have referred 12 newborns for sweat testing. Although it is a small sample size, preliminary results indicate an overall improvement in timeliness. We will continue to track our referrals and intend to present a follow up report to our clinical partners.

Through this project, we have observed key elements that were necessary in improving our follow-up from date of referral to treatment. Close relationships with clinical consultants were vital in facilitating changes at the CF centers. In addition, this project would have been very time consuming if we had not had consistent surveillance of abnormal results. Having strong ties with clinical consultants and maintaining consistent surveillance systems can provide a solid foundation to evaluate and improve upon follow-up procedures. This worked well to help us improve follow-up for CF and this infrastructure for quality improvement can be used for any individual or group of NBS conditions.