# The Book of Health

## INTRODUCTION

Vaccines prevent more than 2 million deaths a year against deadly diseases (World Health Organization, 2012), and are one of the most effective disease prevention methods to date (Plotkin, 2004). Even though multiple studies confirm the importance of early vaccination, parents across a range of socio-economic classes are foregoing vaccinations (Calandrillo, 2005). For some, tables in medical booklets may be difficult to interpret and the medical jargon may be intimidating (Wilson, 2009). With the Book of Health, our goal is to create a simple and legible personal booklet that highlights required, upcoming, and obtained vaccinations.

While technologists hail electronic medical records for their advantages such as networked records, archival, they also have many limitations. Technology is not easily accessible by everyone, and it's prone to error due to flaws in the user interface or lack of user knowledge in technology (Litwin, 2012). Current systems do not support active family involvement, primarily due to the legal and privacy concerns in accessing health data electronically (Tang, 2006). A personal booklet allows one to truly "own" their health history.

We believe a successful personal medical booklet should follow the following design guidelines:

1. Communicate the need for vaccinations to build habitual tracking of personal health.
2. Be legible and easy to interpret by taking advantage of basic visual literacy and using graphical visualizations.
3. Be personalizable to hopefully become a cherished possession as the child transitions into adulthood.

4. Have flexible data input forms to meet the needs of the child, caregiver, doctor, and country.

5. Be easy to archive using existing technology such as webcam or mobile camera and scanner.

Three sections make up our book of health: identity, vaccinations, and personalized information. The design is described below.

## BOOKLET DESIGN

**A. Form Factor**
The child health record is a 4 x 6 inch booklet. This size is sufficiently large to contain all the information, yet portable without sacrificing legibility. The booklet is printed on a mineral-based, waterproof and tear-resistant stone paper. (See submitted booklet.)

**B. Identity**



ID #:                                    The Book of Health for

John Doe

Child's Personal Information
Date of Birth
Weight                          Length
Head Circumference              Blood Type
Address

Family Information
Mother
Father
Siblings

This booklet will help you take care of yourself and protect you from disease as you get older. Doctor, parents, and child should work together to learn from this booklet and keep track of vaccinations and tests.

If found, please return to the address above or:

Figure 1. Identity: The first two (left and right) pages of booklet for recording personal and identification information.

The first two pages (see Figure 1) contain information about the child's identity and family. We embrace redundancy in child identification, for reasons of both security and personalization. A solid-state chip, embedded in the booklet cover, stores identification and vaccination information. This information is initially entered when the booklet is issued and updated after vaccinations in the doctor's office or clinic.

## C. Vaccination Schedule

The vaccination schedule is the centerpiece of the book. We treat the vaccination schedule section as the beginning of lifelong personal health management. It is designed to meet several needs:

1. **Clarity:** It should support ease of search through the vaccination history, including which vaccines, how many doses, and when they were received.

2. **Accountability:** It should make explicit to parents and clinicians when vaccines are overdue. When possible, future dates of administration should be written in the booklet.

3. **Versatility:** It should be flexible to accommodate individual deviations and changes in regulations from the basic schedule.

**Vaccination Schedule**

| | Birth | 6 Weeks | 10 Weeks | 14 Weeks | 9-12 months | 15-18 months |
|---|---|---|---|---|---|---|
| Bacillus Calmette-Guérin (BCG) | ○ | | | | | |
| Hepatitis B vaccine (HepB) | ○ | | | | | |
| Oral Poliovirus vaccine (OPV) | ○ | ○ | ○ | ○ | | |
| Pentavalent combination (Penta) | | ○ | ○ | ○ | | |
| Pneumococcal conjugate vaccine (PCV) | | ○ | ○ | ○ | | |
| Oral Rotavirus vaccine (RV) | | ○ | ○ | ○ | | |
| Measles & Rubella vaccine (MR) | | | | | ○ | ○ |
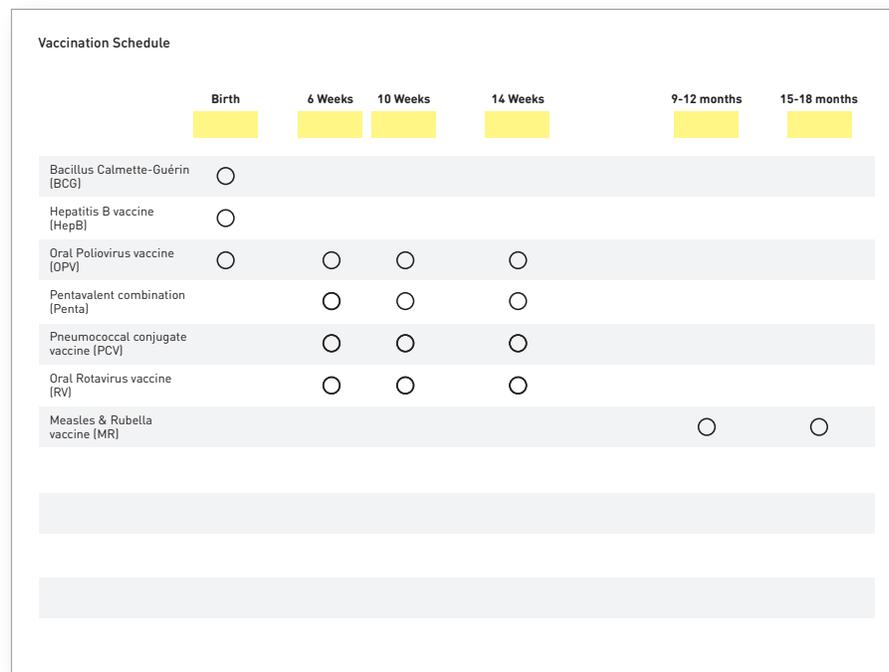
Figure 2. Blank vaccination schedule from birth to 18 months.

These goals are achieved through grouping and graphical visualization. Visualization in medical records has effectively represented previously cluttered clinical data to allow for faster review (Wang, 2006). We use a simple graphical language of circles across a horizontal time line.  Outlined circles next to required vaccinations indicate a required dose. The circles' horizontal placement represents the respective vaccine dosage administration time. (See Figure 2). Upon receiving a dose, the circle outline is filled in at the doctor's or clinician's office. Because children could receive a number of vaccinations at the same time, using this visualization approach, an unfilled circle highlights a missed dosage (See Figure 3).

The additional space surrounding the circle allows for notes (such as appointments

for off-schedule vaccinations), additional dosages, and additional vaccinations.

We envision use of this booklet into adulthood. We therefore include World Health Organization recommended vaccines recommended up to 18 years of age.
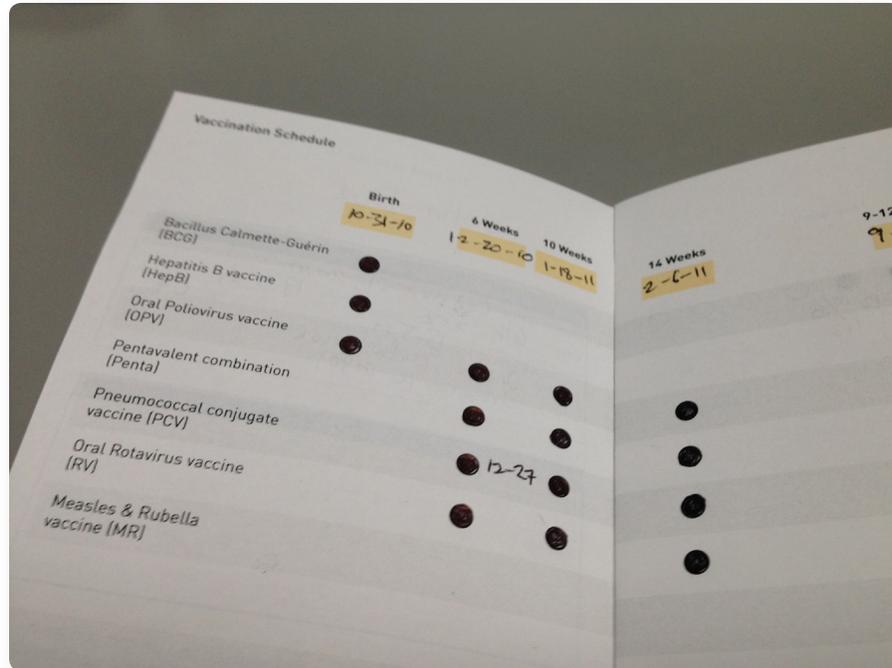


Figure 3. Vaccination schedule in use. In this case, all vaccines have been administered.

*Detailed Vaccination Information*
The graphical vaccination schedule is followed by information highlighting the importance of each vaccine in common language. The language emphasizes that vaccinations protect both the child and others with whom they interact.

**D. Developmental Record**
The remainder of the booklet tracks the child's development milestones. This is the most personalizable part of the booklet. As in today's existing booklets, this section archives common "firsts" in development such as first word. This information may be entered by the parent or health worker. Our hope is that this section becomes a souvenir of sorts. We intentionally suggest only a few milestones for archival to mitigate the stress of constant record-keeping. We also provide space for additional milestone or personal notes. Many existing designs do not allot enough space for such notes, which leads to clutter that affects the overall legibility of the health record (Bill and Melinda Gates Foundation, 2013).

This developmental record section includes growth charts (CDC 2010), a milestone timeline, and open-ended journal documentation (See Figure 4). Every child develops in their own time; this section provides basic educational information relevant primarily to new parents. The open-ended format is not a checklist, but rather, an opportunity to record keepsake memories.

Child Development Record

This section will help guide the parent through the child's life. This timeline only acts as a general guideline for developmental milestones. Each child develops differently and some may even skip milestones. Parents are encouraged to keep a record of their child's development and give this booklet to the child when he or she turns into an adult.

**2 Months**
Umbilical cord falls off:

First toy:

Smiles at:

Scared of:

**4 Months**
Laughs at:

First solid food:

**6 Months**
First Tooth:

First time sleeping through the night:

Figure 4. Developmental record. Milestones and "firsts" are tracked on the right side of the pages. The left side is available for open-ended journaling.

*Scheduling Visits*

The last pages consist of a table for adding a date for the next expected clinical visit. This section is separate to minimize the potential risk of confusing the next visit date with any other dates in the booklet. The goal is to emphasize appointments within the first year of life and yearly checkups, hence we don't include many pages.

## RECORD KEEPING AND AUTHENTICITY

### A. Archival

While we advocate for a paper booklet, we designed one with clean and concise graphics that can be scanned or photographed by camera phones or digital cameras. The specific circle patterns are easily parsed into digital format using existing technology. Current optical mark recognition systems capture filled circles with close to 100 percent accuracy (Bergeron, 1998). This data can also be stored on the embedded solid-state chip and in a clinic database if available. We recommend capturing the two 2-page spreads of vaccine graphics after every vaccine administration visit.

### B. Authenticity

Parental vaccination self reports may be incorrect due to overestimation, underestimation, or non-compliance of parents. A study on the validity of parent-reported immunizations produced false-positives of over 30% of critical immunizations, including two listed on our schedule, MMR and Tdap (Dorell, 2011). In some scenarios, this record could become the main document for

proof-of-vaccination. Therefore, verifying the authenticity of vaccination administration may be necessary. We designed an optional procedure to reduce record tampering; we provide doctors with a unique invisible stamp viewable only under UV lighting. This stamp imprint extends beyond the boundaries of the circle in a unique security pattern (see Figure 5).
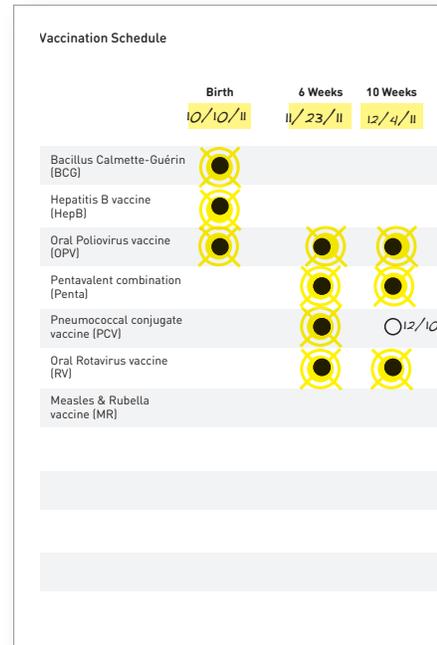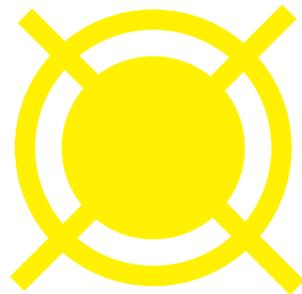


Figure 5. Example of a security stamp (left) and how it would look under UV lighting (right).

## CONCLUSION

In our vaccine schedule, we implement data visualization techniques to (1) help families track scheduled vaccinations, (2) reveal vaccination schedule irregularities to parents and health care workers, and (3) quickly archive vaccination records. In the unfortunate case of an accident or sudden inability of the caretaker to care for a child, this record provides the necessary information to maintain proper health care. We hope that through education and clarity, we can build a healthy and informed global community.

**REFERENCES**

Bergeron, B. P. (1998). Optical mark recognition. Postgraduate medicine,104(2).

Bill and Melinda Gates Foundation. (2013) Records for Life Contest. Retrieved from http://www.gatesfoundation.org/How-We-Work/General-Information/ Grant-Opportunities/Records-for-Life-RFP

Center for Disease Control (CDC). (2010) Growth Charts. http://www.cdc.gov/ growthcharts/

Calandrillo, S. P. (2005, May). Vanishing vaccinations: why are so many Americans opting out of vaccinating their children? In American Law & Economics Association Annual Meetings (p. 24). bepress.

Dorell, C. G., Jain, N., & Yankey, D. (2011). Validity of parent-reported vaccination status for adolescents aged 13–17 years: National Immunization Survey-Teen, 2008. Public Health Reports, 126(Suppl 2), 60.

Litwin, A. S., Avgar, A. C., & Pronovost, P. J. (2012). Measurement Error in Performance Studies of Health Information Technology: Lessons from the Management Literature. Applied clinical informatics, 3(2), 210.

Plotkin, S. L., & Plotkin, S. A. (2004). A short history of vaccination.

Tang, P. C., Ash, J. S., Bates, D. W., Overhage, J. M., & Sands, D. Z. (2006). Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. Journal of the American Medical Informatics Association,13(2), 121-126.

Wang, T. D., Plaisant, C., Quinn, A. J., Stanchak, R., Murphy, S., & Shneiderman, B. (2008, April). Aligning temporal data by sentinel events: discovering patterns in electronic health records. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 457-466). ACM.

Wilson, M. (2009). Readability and patient education materials used for low-income populations. Clinical Nurse Specialist, 23(1), 33-40.

World Health Organization. (2012) World Immunization Week 2012. Retreieved from http://www.who.int/immunization/newsroom/events/immunization_ week/2012/