Supplemental Digital Appendix 1

Details of Method Used in Authors' Previous Reports Describing Screen-Based Simulations, Using the Pediatric Ankle Radiograph as a Model

Study Population: We approached medical students (MS), emergency medicine and pediatrics residents, pediatric emergency medicine fellows (grouped as RES) and attending pediatric emergency medicine physicians and pediatric radiologists (ATT) at 2 study institutions (The Hospital for Sick Children, Toronto, ON, Canada and Columbia University Medical Center, New York, NY). Enrolled trainees were provided a link to the study website by email as well as a unique username and password. Over a 4 month period in 2008, they completed radiograph cases in a serial fashion. IRB approval was obtained at both study institutions and all participants provided signed informed consent. A $25 gift certificate was provided at completion of all cases.

Educational Intervention: We downloaded from the Hospital for Sick Children Radiology Information System 378 ankle three-view radiograph cases taken for patients of the Pediatric Emergency Department for the purposes of excluding a traumatic fracture (see Figure 1). After excluding suboptimal cases, the final learning set was made up of 234 cases of which approximately 62% were normal (free of fracture) and 38% abnormal with a spectrum of illness consistent with that seen in clinical practice. The relative distribution of diagnoses is presented in the original report (reference 23).

The cases were presented in a random order, different for each participant, in order to prevent an idiosyncratic sequence from confounding our plotting of learning curves; that is, if by chance we had presented more difficult cases early in the sequence and easier ones later, there would have been a learning effect simply due to chance that we could not have detected. We did not provide participants information as to the proportion of abnormal cases.

Each case was presented within a PHP/Flash^{TM} hybrid shell that allowed the use of interactive graphics including having each participant exactly designate any area of abnormality right on the radiograph image. There was a rudimentary zoom capability but no specific capacity to adjust grey-scale, brightness, alpha or other image enhancements. All click level information, including Page and Case type (Figure 2 and Figure 5), time-stamps to the second (Figure 3 and x,y coordinates of abnormality designations (Figure 4) were recorded to a mySQL server-side database.

Study Procedure: Under no time constraints, the participants were allowed to consider the 3 views of the ankle as well as an initial history page. Each view, the history page, and the radiology report are presented on distinct, named pages that were separately time-stamped. After sufficient review, the participant could, from any of the images, submit their diagnosis of Normal vs. Abnormal and, in the case of the latter, designated with their mouse cursor the location of the abnormality (Figure 1). We supplied immediate feedback in the form of the treating radiologist's dictated report, which served as the gold standard interpretation. Cases were completed in several sessions, enabled by a book-marking feature of the software that allowed the participant to resume where they had left off.

Statistical Analyses: Each case completion consisted of one item. A case was scored correct if either the participant designated a normal case normal, or the converse with the added stipulation that the indication of the fracture be in the correct location, as had been predetermined using mask layers on the image using Photoshop and Flash (Adobe Systems). We report the following descriptive statistics: number of lookbacks to the Clinical History page (count and proportion of cases with at least one such count); number of cases where participant considered fewer than all 3 views (count); time on case being the difference between the time when the first Clinical History page loaded and when the answer was “submitted”. Outlier time estimates were censored at 5 minutes since we did not have a way of accounting for the participant being interrupted during a session. The regression modelling used to correlate the proportion of cases where the Clinical History was re-consulted was carried out in both Stata and in Excel (See Figure 2) in which we calculated for each participant the proportion of cases where they explicitly re-consulted the Clinical History and their overall Accuracy score (proportion of cases correctly interpreted). Individual regression lines are plotted for each of the three levels of participant (MS, RES, ATT).

Visualizations: To generate the smoothed time-on-case curves (Figure 3), for each experience level, 20-point moving averages were calculated in a Microsoft™ Excel spreadsheet. The averaged dataset was then transferred into a second worksheet that contained a customized 2nd-order phaseless Butterworth low pass filter algorithm. The algorithm extrapolated a linear trend for each experience level at the start and terminal parts of the dataset and generated "padded" values to the respective start/finish portions of the dataset. An adjustable cut-off frequency cell was used by the algorithm to then calculated the appropriate filtering coefficients. The datasets were passed through the filtering algorithm forwards and then reversed in order to remove any phase distortions[1] [Winter]. A visual residual analysis was performed between the filtered and unfiltered signals to determine the optimal cut-off frequency.

To generate the Heat Maps (Figure 4), we used a php script to extract subject responses from the mySQL database. For each ankle case, mouse-click x and y coordinates were converted to json format for each of the views. The resultant dataset for each case was served into a web-browser to display both the required view of the ankle and a heatmap overlay rendered using heatmap.js™ software.[2]

The path maps (Figure 5) were programmed using a custom PHP script that is based on the mySQL data fields that associate time-stamped data for when one of the component images is loaded and then unloaded.

1. Winter, DA. Biomechanics and Motor Control of Human Movement. John Wiley & Sons, Inc. Hoboken, New Jersey, 2009.

2. http://www.patrick-wied.at/static/heatmapjs/

