11 Using the Breast Reconstruction Risk Assessment (BRA) Score: An Individualized Risk Calculator to Assist Expectation Management and Reconstructive Decision Making in the Mastectomy Patient

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Introduction: The Utility of Risk Calculators

Over 100,000 breast reconstructions are now performed annually in the United States alone [1]. The reconstructive surgeon has a variety of modalities to choose from, and there is a large body of literature addressing the risks and benefits of each [2–15]. These papers can present a daunting and sometimes conflicting array of risk factors for numerous complications, each meant to assist in incremental risk stratification. Risk calculators simplify this process by providing concrete estimates based on the *combined* characteristics of the *individual* who is undergoing surgery.

While many superb papers have set benchmarks and informed clinical practice, the majority provide population-based estimates of risk, drawn from the average of the population studied. However, there are two pitfalls in attempting to apply these. First, risk of any given complication is often broadly distributed and skewed. Thus, the average may provide an overestimate for many, and a crucial underestimate for others. Second, the averages are often hard to reconcile into a reliable gestalt when there are multiple comorbidities or conflicting characteristics. As a result of these issues, surgery is, like many fields, moving away from high-level, population-based averages and the resultant uncertainty in their application, and towards data-driven, granular tactics to personalize the conversation [16–21].

The final benefit of risk calculators is their interactive nature. Whether online or on a mobile device, an increasing premium is put on the ability to engage patients in discussions about their health and grant them a degree of efficacy [22, 23]. This, in turn, supports expectation management, as the engaged patient is able to see in real time what her risks are given various situations or modalities. This multitude of benefits has led the Center for Medicare and Medicaid Services (CMS) to consider incentivizing patient-specific discussion of risk before every elective operation [24].

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What Is the BRA Score?

The Breast Reconstruction Risk Assessment (BRA) Score is an easy-to-use and open-access risk calculator for reconstructive surgeons and their patients [25–29]. It is available online at www.BRAScore.org. More recently, it has been made available as a mobile phone app, for Android operating systems. The online and mobile platforms function similarly, accepting preoperative and treatment characteristics of a given patient, and returning predicted probabilities of each of five surgical complications, as well as reoperation and medical complications. These predicted probabilities differ by method of reconstruction, and are laid out as such.

Details of the methodology utilized to construct the BRA Score have been well described in the literature [25–29]. The calculator is based on data from high-quality, large-scale registries including the American College of Surgeons' National Surgical Quality Improvement Program (ACS-NSQIP), the American Society of Plastic Surgeons' Tracking Operations and Outcomes for Plastic Surgeons (ASPS TOPS), and the Mastectomy Reconstruction Outcomes Consortium (MROC). Logistic regression was used to assess for independent risk factors for each outcome of interest. The results of these regressions, specifically the constants and beta values, are transformed into predicted probabilities using a logit function [30, 31]. In order to make this analysis intuitive and clinically useful, the user interface simply takes characteristics of an individual and presents final results of this statistical prediction model. This process is depicted in Fig. 11.1.

A striking example of the utility of individualized risk calculators is seen in the broad and skewed distribution in predicted risk among the cohort used to develop the BRA Score. Figure 11.2 depicts the broad and skewed distribution of risk of surgical complications overall within the TOPS cohort. Figure 11.3 demonstrates that this holds across all complications, as the minimum and maximum predicted probabilities among this cohort widely differ for each complication.

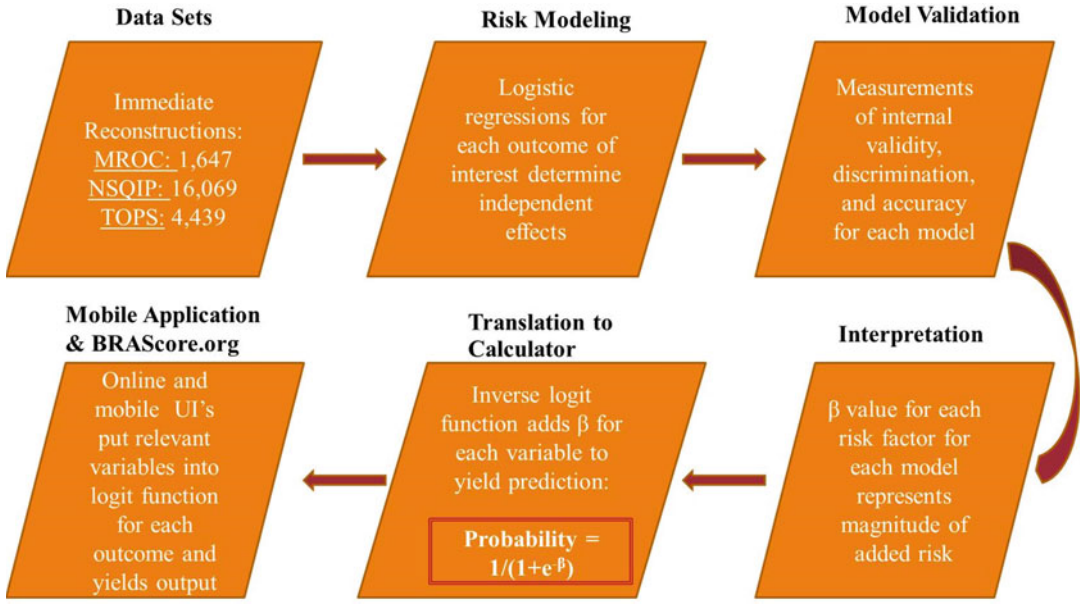

Fig. 11.1 BRA Score development methodology

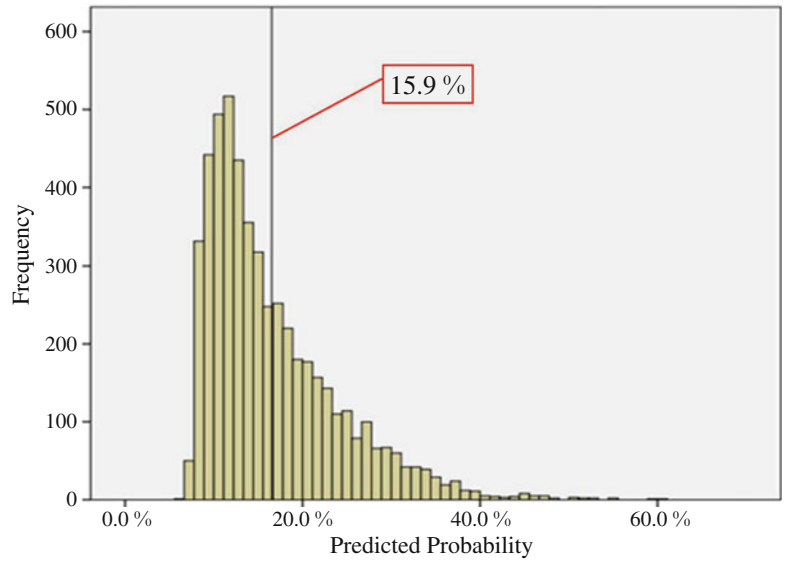

Fig. 11.2 Histogram depicting distribution of predicted probabilities of surgical complications across the TOPS reconstruction cohort

Fig. 11.3 Average incidence, minimum predicted probability, and maximum predicted probability of each complication examined within the TOPS cohort

Complication	Overall Incidence	Minimum Probability	Maximum Probability
Seroma	3.37%	1.21%	22.24%
SSI	3.96%	0.87%	29.89%
Dehiscence	6.13%	2.22%	50.19%
Flap Failure	7.00%	1.24%	50.57%
Explantation	3.70%	1.14%	52.08%
Reoperation	6.42%	1.79%	23.01%
Overall	15.92%	6.84%	62.50%

How Should the BRA Score Be Used?

The BRA Score was developed for use by reconstructive surgeons and their patients. It has potential utility in both surgical planning and informed consent. Seeing quantifiable risk estimates for different complications across various modalities can help the surgeon weigh them against the advantages of each modality. Similarly, walking a patient through this information can increase her involvement in and understanding of the surgical planning process. However, the BRA Score should *not* be used to determine surgical *candidacy* for any patient. It yields only one side of a two-sided equation and cannot replace the clinical judgment of the reconstructive surgeon. Similarly, it cannot be the sole basis of the informed consent process, but helps facilitate it with accessible and consolidated risk information. It is important to note the limitations of data from which the BRA Score is derived, as well as the absence to date of a study examining the tool's external validity.

Case-Based Examples of BRA Score Utilization

It is easiest to discuss the use and utility of the BRA Score with actual case-based examples. The examples that follow are two hypothetical patients undergoing mastectomy with immedi-

ate breast reconstruction. Let's look at these patients and use the BRA Score to quantify the difference in risk for these two women. For demonstration purposes, one case example will be assessed using the BRA Score website, while the second will be assessed using the BRA Score App.

Patient A is a 30-year-old woman who has chosen to undergo a prophylactic risk-reducing double mastectomy for her recently diagnosed BRCA carrier status. She is 5′6″ tall and weighs 120 lbs. She does not smoke and has no comorbidities. This is the type of patient that is seen more and more often in clinical practice as we witness continuing improvements and the publicity in both genetic testing for and prophylactic treatment of high-risk mutations [32] www.BRAScore.org.

We start at the landing page in Fig. 11.4, which outlines some of the uses and limitations discussed above. We acknowledge understanding and click "Proceed."

The homepage in Fig. 11.5 presents us with the characteristics that are taken into account in the BRA Score statistical models. There are demographics, comorbidities, and treatment details to fill in. Once these are complete with the details for "Patient A," we can click the "Calculate Risk" button that appears, as in Fig. 11.6.

We see a risk profile that pops up for Patient A, shown in Fig. 11.7. In interpreting this, there are a few things to note, independent of the actual results. One is the superscript on various categories. These tell us which cohort the data is derived from. For example, the latest work with the Mastectomy Reconstruction Outcomes Consortium (MROC) [29] yielded sufficient statistical power only for an analysis of "overall" complications, but had more single stage cases than prior studies, allowing for inclusion of those patients. Thus, the single-stage modality, the newest addition to the BRA Score, has a result for only "overall" complications. Similarly, the studies from which each data point is

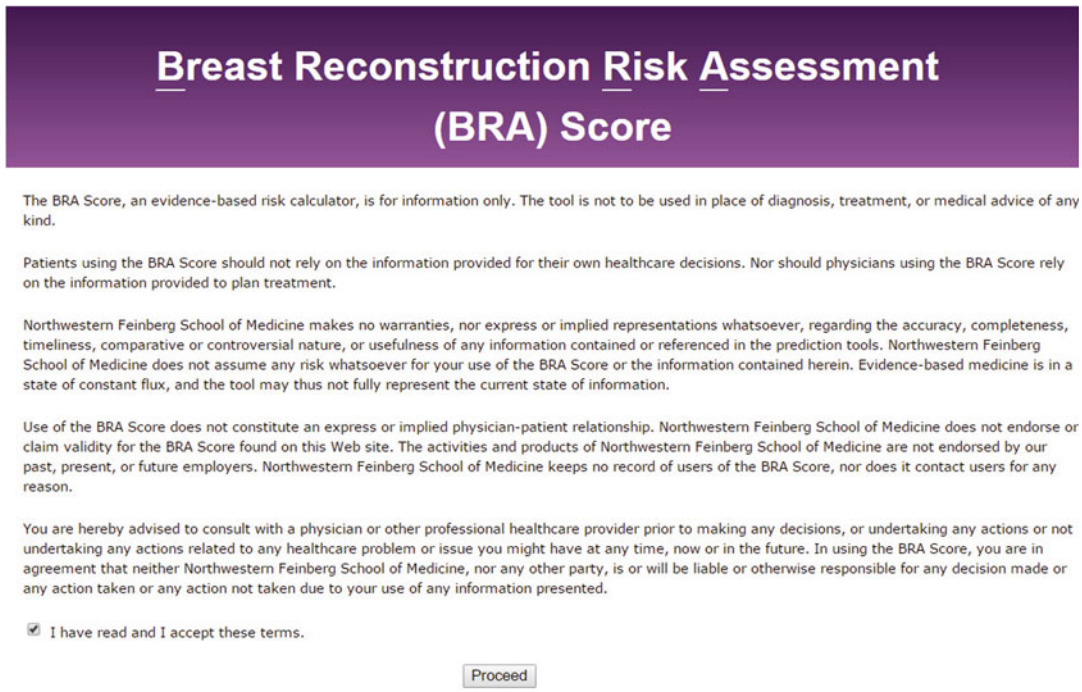

Fig. 11.4 Landing page screenshot

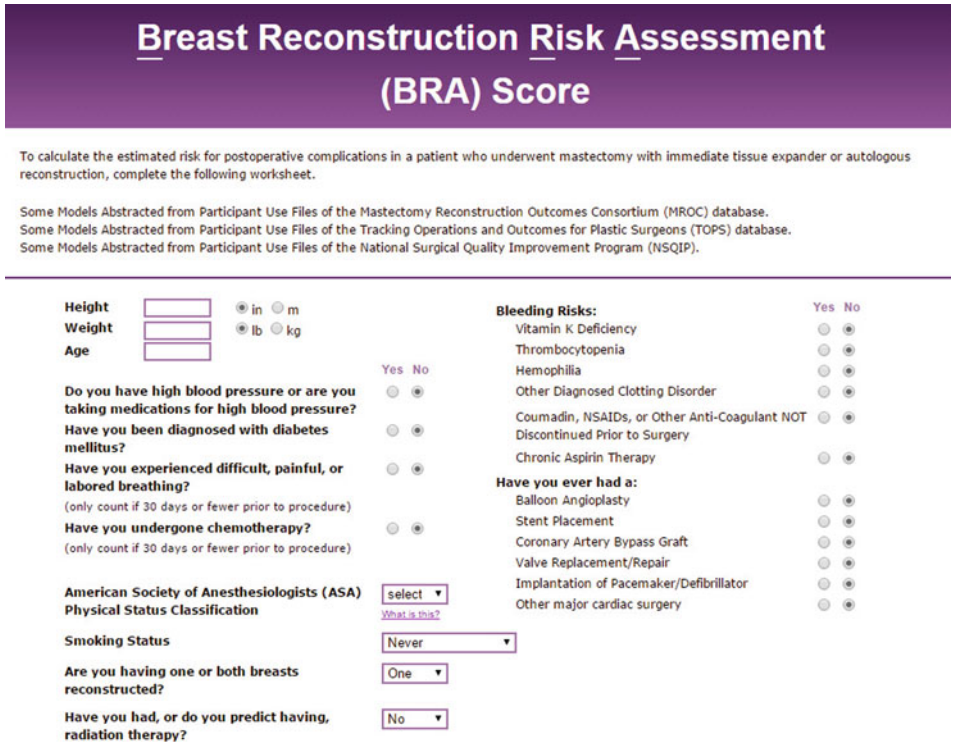

Fig. 11.5 Blank homepage

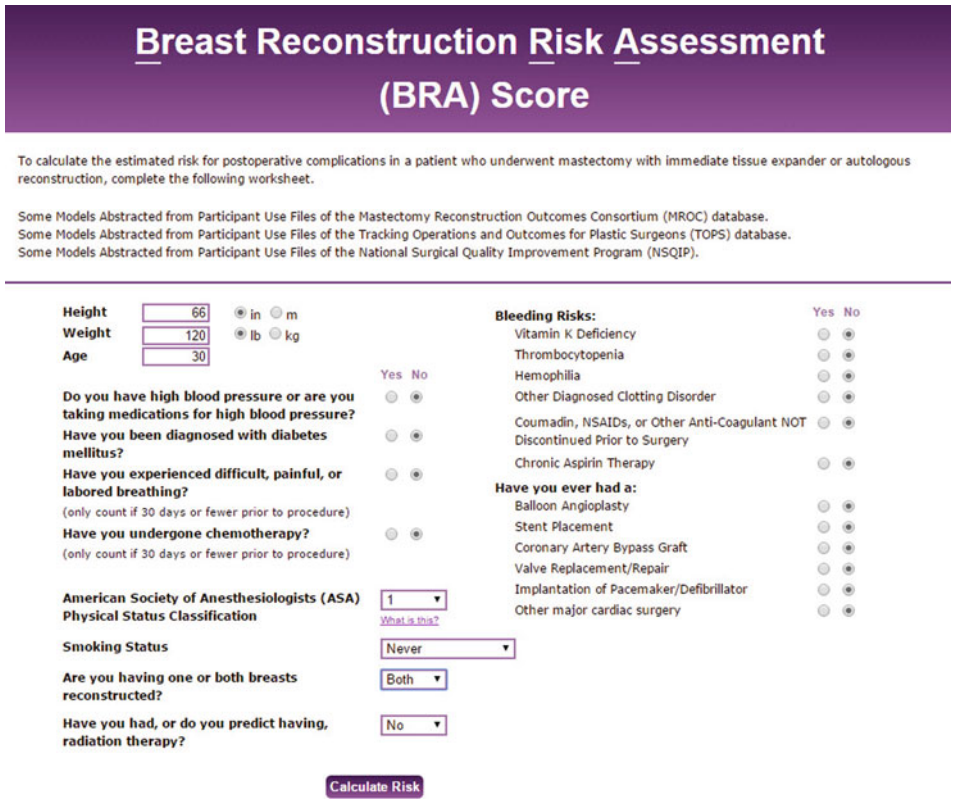

Fig. 11.6 Completed questions for "Patient A"

Estimated Risk of Complication:

Outcome	Reconstructive Modality				
	Tissue Expander	Pedicled Abdominal (TRAM) Flap	Latissimus Flap	Microvascular Reconstruction	Single-Stage Implant
Overall Complications	7.61%[1] - 7.63%[2]	17.78%[1] - 22.55%[2]	12.17%[1] - 28.37%[2]	12.93%[1] - 22.78%[2]	16.52%[2]
Overall Medical Complications[3]	1.08%	3.98%	1.49%	8.15%	
Overall Surgical Complications[1]	7.61%	17.78%	12.17%	12.93%	
Surgical Site Infection[3]	1.54%	2.50%	1.14%	2.59%	
Seroma[1]	1.10%	1.93%	3.55%	1.66%	
Dehiscence[1]	2.63%	9.77%	3.61%	4.46%	
Flap Loss (Partial or Total)[1]	n/a	4.42%	1.20%	4.27%	
Explantation[1]	1.42%	n/a	n/a	n/a	
30-Day Reoperation[1]	2.70%	4.39%	1.98%	4.84%	

[1] Abstracted from TOPS data
[2] Abstracted from MROC data
[3] Abstracted from NSQIP data

Fig. 11.7 Complication predictions for "Patient A" stratified by reconstructive technique

estimated vary in the exact definitions of the input and their weighting in the regressions. For example, those with granular familiarity with the ACS-NSQIP database know that it lacks thorough radiotherapy information [33]. Thus, the information that we input regarding radiotherapy is not factored into estimates based on NSQIP data, but is used for those derived from MROC data.

We can see from the probabilistic estimates in Fig. 11.7 that Patient A is a fairly low-risk patient across the board, as expected. Though we can intuit that she has a "low" risk of complications relative to published means, it is beneficial to have numerical estimates, particularly in this increasingly common patient with little outcomes data available because of the rarity of her situation prior to the era of testing and prophylactic double mastectomy.

Patient B is a 65 year-old woman undergoing unilateral mastectomy for a newly-diagnosed invasive ductal carcinoma and wants to minimize added procedures including those to the contralateral breast. She is 5′6″ tall and weighs 170 lbs. She smokes, but has agreed to quit 30 days prior to the procedure. She also has diabetes and hypertension. She has been deemed American Society of Anesthesiologists (ASA) class II due to the burden of her comorbidities.

The app is freely available in the Google Play and Apple Apps store for Android, respectively. We download and open the app to arrive at the screen depicted in Fig. 11.8. Information within

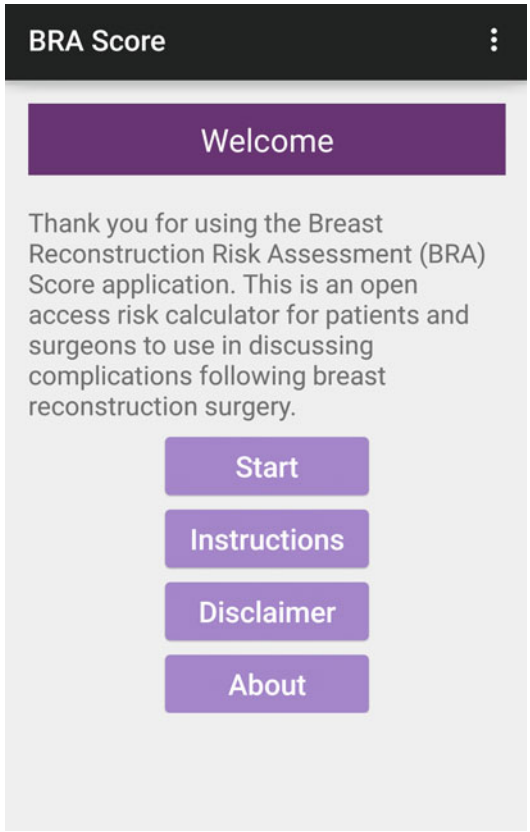

Fig. 11.8 Home screen of BRA Score mobile application

the "Instructions," "About Us," and "Disclaimer" options are largely covered above, so we will proceed to press "Start."

The app walks us through several questions, capturing the same information that is captured by the online interface in Fig. 11.9. After answering the last question and pressing "Next," a review screen is offered to ensure that all questions were answered correctly and giving us the opportunity to change answers as appropriate, as shown in Fig. 11.10. When all characteristics are correctly entered, pressing "Results" takes us to the output.

The BRA Score app output for Patient B is depicted in Fig. 11.11. As expected, we see significantly higher risks across all categories than we did for Patient A. The default modality displayed on the results screen in the app is staged expander-implant reconstruction. However, we can also view predicted risks for autologous reconstructions. When selecting "Latissimus Flap," for example, the results array changes to reflect the predicted probabilities for the relevant surgical technique, as shown in Fig. 11.12. Again, more specific numerical estimates of risk in this context allow for better cross-technique

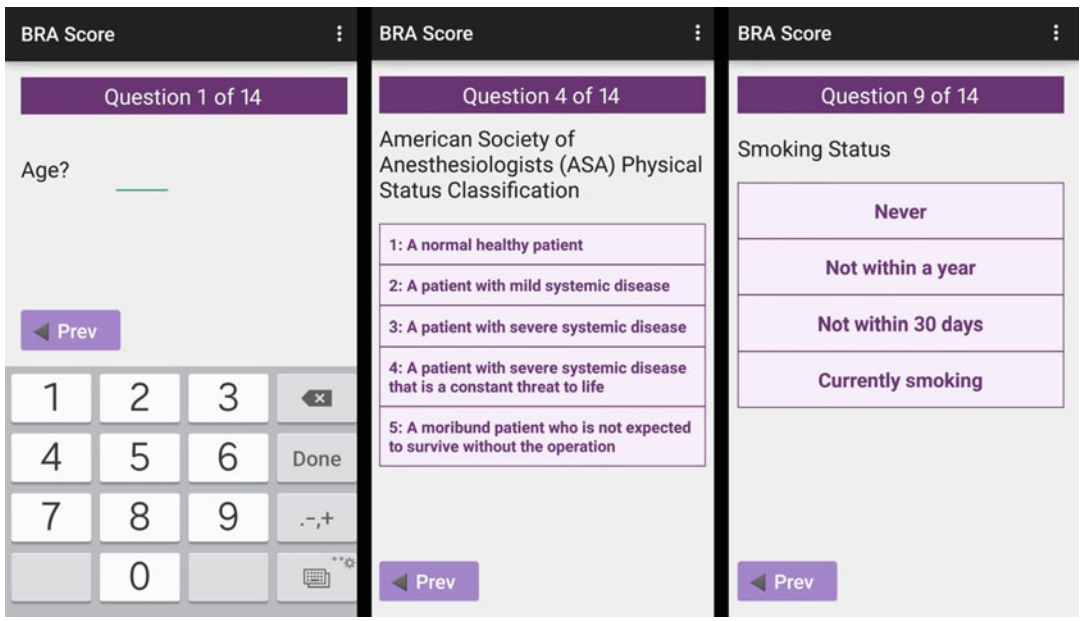

Fig. 11.9 Sample question screens in mobile application

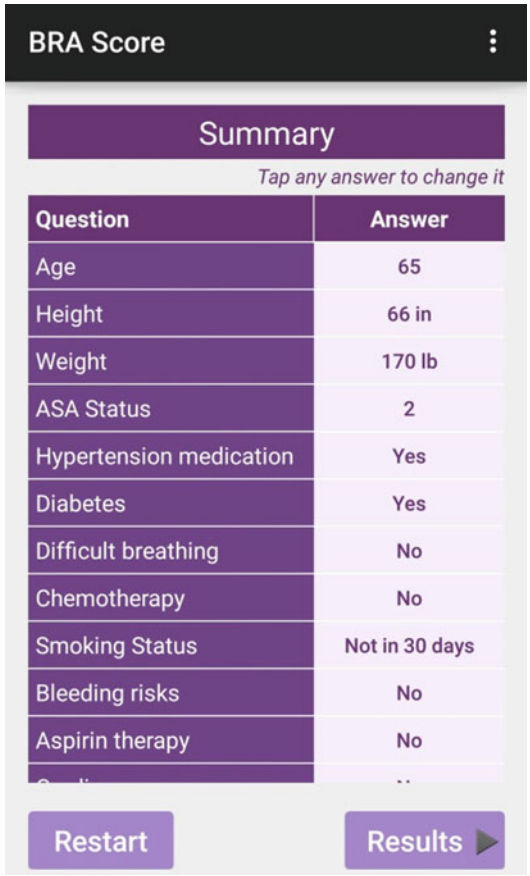

Fig. 11.10 Information review screen

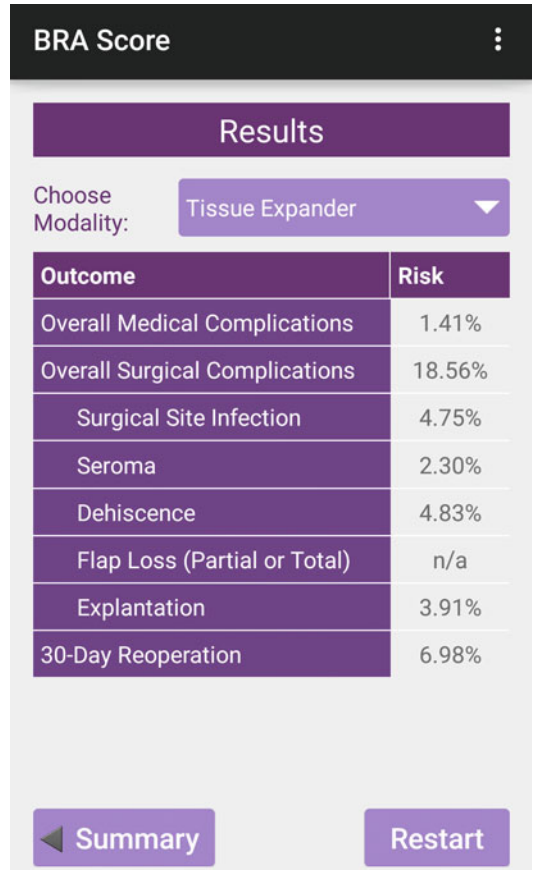

Fig. 11.11 Complication predictions for "Patient B" using tissue expander reconstruction

comparisons and expectation management. One notable limitation to the former use in this context is the fact that the data from which the risk models were derived code using Current Procedural Terminology (CPT) codes, which preclude differentiation between microvascular techniques.

Summary

The Breast Reconstruction Risk Assessment (BRA) Score is an evidence-based tool that provides individualized estimates of postoperative complication risk in immediate breast reconstruction. It is available as both online (www.BRAScore.org) and mobile (Android) platforms for free and easy access to reconstructive surgeons and their patients. Taken with appropriate clinical judgment, patient selection, and informed consent procedures, the BRA Score can be a useful part of surgical decision-making and expectation management. Limitations to both formulation and use of the BRA Score should be kept in mind when using it. A follow-up prospective study of both predictive accuracy and patient satisfaction is warranted.

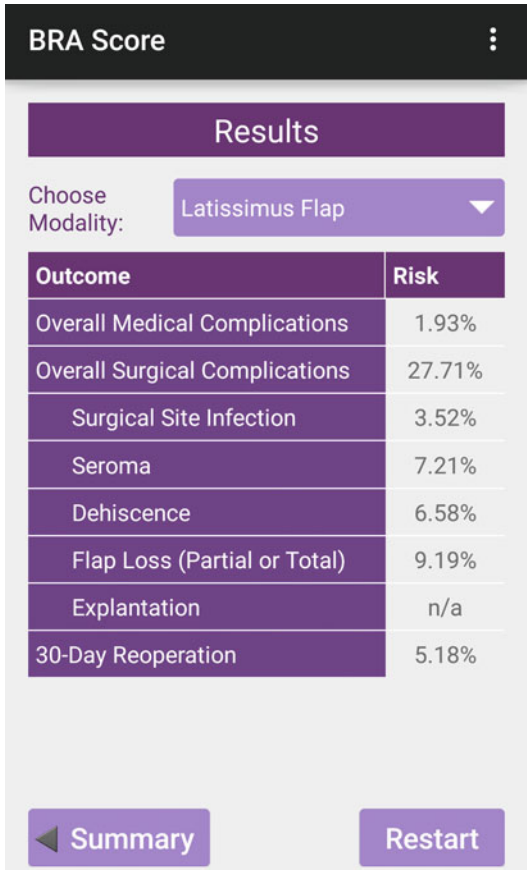

Fig. 11.12 Complication predictions for "Patient B" using latissimus flap reconstruction

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