

TABLE E-1 Elbow-Specific Aggregate Outcome Measures Used in the TEA Literature*		
Elbow-Specific Outcome Measures	No. of Studies	Percentage of Studies
MEPS or variation	53	74%
ASES	4	6%
HSS	3	4%
EFA	2	3%
LES	2	3%
HSS2	1	1%
Unique scale of authors	6	8%
No scale	7	10%
<p>*Six different elbow-specific aggregate outcome measures were employed in the review of seventy-two articles. A separate row represents the articles in which the authors used their own unique aggregate measure, and another row represents the articles that did not use an elbow-specific aggregate measure at all. Some of the seventy-two articles used more than one measure, thus the total percentage was &gt;100%. TEA = total elbow arthroplasty, HSS = Hospital for Special Surgery scoring system, HSS2 = Hospital for Special Surgery Total Elbow scoring system, EFA = Elbow Functional Assessment, LES = Liverpool Elbow Score, MEPS = Mayo Elbow Performance Score, and ASES = American Shoulder and Elbow Surgeons elbow assessment form.</p>		

**TABLE E-2 Review of the Characteristics of the Elbow-Specific Aggregate Outcome Measures**

Elbow-Specific Aggregate Outcome Measure	Date of Measure	Development of Measure*	Patient Sample†
Hospital for Special Surgery scoring system (HSS)	1980	Developed to quantify the preoperative versus postoperative results of TEA, whereby treatment goals were mobility, stability, and freedom from pain	RA, JRA, PTA
Hospital for Special Surgery Total Elbow scoring system (HSS2)	1990	Developed to express the results of reconstruction after implant removal for failed TEA	RA, PTA
Mayo Elbow Performance Score (MEPS)	1992	In 1983, the first iteration of the MEPS, known as the “Morrey and Bryan” score, had pain, motion, and stability subscales. In 1992, the Mayo Clinic Performance Index (MCPI) for the elbow added a function subscale. The scoring for the MCPI was further refined in 1993 and presented as the MEPS.	RA
American Shoulder and Elbow Surgeons elbow assessment form (ASES) 1. Patient self-evaluation form (pmASES) 2. Clinical assessment portion (cmASES)	1993	Developed to encourage multicenter research by improving communication among clinicians treating elbow pathology and included two iterations by the ASES Research Committee after a review of all elbow scoring systems. The patient part has 3 sections: pain, function, and satisfaction. The physician part has 4 sections: motion, stability, strength, and signs. While each question has a scale assigned, no overall score or weightings of the subscales were described.	All elbow pathology
Elbow Functional Assessment (EFA)	1999	Developed to assess elbow function in patients with RA using a formal process of item generation and reduction	RA
Liverpool Elbow Score (LES)	2004	Developed to measure pain, function and disability simultaneously, and to use a formal process of item generation and reduction to formulate the scale	RA, OA
*TEA = total elbow arthroplasty. †RA = rheumatoid arthritis, JRA = juvenile rheumatoid arthritis, PTA = posttraumatic arthritis, OA = osteoarthritis. An overview of each of the six elbow-specific aggregate outcome measures used by the articles in this review is listed in the table. It includes the date the measure was developed and key features of its development as well as the patient population it was developed in or for.			

TABLE E-3 MEDLINE Search Method
Database: Ovid MEDLINE <1948 to July Week 3 2011>
<p>Search Strategy</p> <p>1 exp Arthroplasty, Replacement/ or “prostheses and implants”/ or joint prosthesis/ (63442)</p> <p>2 Elbow Joint/ or elbow/ (12285)</p> <p>3 1 and 2 (840)</p> <p>4 (elbow adj2 (replac* or arthroplast*)).ti,ab. (539)</p> <p>5 4 or 3 (971)</p> <p>6 limit 5 to (english language and yr=“2004 -Current”) (338)</p>

TABLE E-4 Embase Search Method
Database: Embase <1980 to 2011 Week 30>
<p>Search Strategy:</p> <p>1 joint surgery/ or arthroplasty/ or joint prosthesis/ (18167)</p> <p>2 Elbow/ (10035)</p> <p>3 1 and 2 (651)</p> <p>4 (elbow adj2 (replac* or arthroplast*)).ti,ab. (621)</p> <p>5 3 or 4 (1008)</p> <p>6 limit 5 to (english language and yr=“2004 -Current”) (363)</p>

**TABLE E-5 Outcome Measures in Total Elbow Arthroplasty According to the Wilson and Cleary Conceptual Model\***

Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Duke University, North Carolina Aldridge et al. <sup>12</sup> (2006)	MEPS	Radiolucency, implant survival, complications			Satisfaction	
Northern General Hospital, Sheffield, UK Ali et al. <sup>13</sup> (2010)	MEPS	Radiolucency, ROM, complications				
Bristol Royal Infirmary, Bristol, UK Amirfeyz and Blewitt <sup>54</sup> (2009)	MEPS, LES	Radiolucency, implant survival, complications, ROM, triceps strength				
Mayo Clinic, Rochester, Minnesota Athwal and Morrey <sup>11</sup> (2006)	MEPS	Radiolucency, bushing wear, bone loss, complications				
Blaine et al. <sup>14</sup> (2005)	MEPS	Radiolucency, bushing wear, ROM				
Celli and Morrey <sup>15</sup> (2009)	MEPS	Radiolucency, implant survival, complications, ROM				
Cheung et al. <sup>16</sup> (2008)	MEPS	Implant survival, complications				
Cil et al. <sup>17</sup> (2008)	MEPS	Radiolucency, bushing wear, implant survival, complications, ROM			Subjective assessment (much better, better, same, worse)	
Jost et al. <sup>18</sup> (2008)	MEPS	Radiolucency, complications, ROM			Satisfaction (very satisfied, satisfied, disappointed, or not satisfied)	
Kamineni and Morrey <sup>19</sup> (2004)	MEPS	Radiolucency, complications, graft incorporation				

TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Kamineni and Morrey <sup>20</sup> (2004)	MEPS	Radiolucency, bushing wear, HO, implant survival, complications	Crepitus and/or squeaking			
Lee et al. <sup>21</sup> (2005)	MEPS	Radiolucency, bushing wear, implant survival, complications, ROM				
Levy et al. <sup>72</sup> (2009)		Implant survival, complications				
Loebenberg et al. <sup>22</sup> (2005)	MEPS	Radiolucency, implant survival, complications			Subjective assessment (much better, better, same, worse); satisfaction (Y/N)	
Mansat et al. <sup>23</sup> (2004)	MEPS	Radiolucency, implant survival, complications, ROM				
Marra et al. <sup>24</sup> (2006)	MEPS	Radiolucency, complications, strength				
Peden and Morrey <sup>25</sup> (2008)	MEPS	Radiolucency, bushing wear, implant survival, complications, ROM				
Throckmorton et al. <sup>26</sup> (2010)	MEPS	Radiolucency, bushing wear, implant survival, complications, ROM				
Whaley et al. <sup>27</sup> (2005)	MEPS	Radiolucency, implant survival, complications, ROM	Categorical pain scale (none, mild, moderate, severe)		Subjective assessment (much better, somewhat better, unchanged, worse)	
Medical College and Hospital, Kolkata, India						
Baksi et al. <sup>28</sup> (2009)	MEPS	Radiolucency, complications, ROM				

TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Wrightington Hospital, Wigan/Lancashire, UK						
Bassi et al. <sup>55</sup> (2007)	MEPS, ASES	Radiolucency				
Naqui et al. <sup>53</sup> (2010)	MEPS, ASES	Radiolucency, implant survival, complications, ROM, strength	Pain VAS			
Talwalkar et al. <sup>73</sup> (2005)		Radiolucency, implant survival, complications, ROM	Pain VAS	Unique functional inquiry	Subjective assessment (excellent, good, satisfactory, no change, poor)	
Sint Maartenskliniek, Nijmegen, The Netherlands						
Brinkman et al. <sup>62</sup> (2007)	EFA	Radiolucency, implant survival, ROM, HO, implant alignment				
Lapeyronie University Hospital, Montpellier, France						
Cesar et al. <sup>29</sup> (2007)	MEPS	Radiolucency, implant survival, complications, ROM				
University, of Leeds, Leeds, UK						
Chalidis et al. <sup>30</sup> (2009)	MEPS	Radiolucency, implant survival, complications				
Parma Hospital, Parma, Italy						
Corradi et al. <sup>31</sup> (2010)	MEPS	Radiographs		DASH		
Southampton University Hospitals, Southampton, UK						
Crook et al. <sup>10</sup> (2008)	MEPS	Complications	Pain VAS	DASH		
University Hospitals Leuven, Pellenberg, Belgium						
Degreeef et al. <sup>32</sup> (2008)	MEPS	Complications, metallosis		DASH		

TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Willems and De Smet <sup>56</sup> (2004)	MEPS, HSS2	Radiolucency, implant survival, complications, ROM				
Gulhane Military Medical Academy, Ankara, Turkey						
Demiralp et al. <sup>33</sup> (2008)	MEPS	Radiolucency, implant survival, complications				
Roger Salengro Hospital, University of Lille II, France						
Dos Remedios et al. <sup>34</sup> (2005)	MEPS	Radiolucency, implant survival, ROM	Pain (VAS, Gschwend classification); paraesthesia (ulnar nerve)	Functional classification according to Steinbrocker	Satisfaction	
Hospital for Special Surgery, New York, NY						
Figgie et al. <sup>63</sup> (2006)	HSS	Implant survival				
Endoklinik, Hamburg, Germany						
Gille et al. <sup>35</sup> (2006)	Morrey and Bryan	Radiolucency, implant survival, complications				
Rheumatism Foundation Hospital, Heinola, Finland						
Ikävalko et al. <sup>74</sup> (2004)		Implant survival, complications, ROM				
Ikävalko et al. <sup>75</sup> (2010)		Implant survival, complications				
Kyoto University Graduate School of Medicine, Sakyo, Kyoto, Japan						
Ito et al. <sup>37</sup> (2007)	MEPS	Radiolucency, implant survival, complications, ROM, strength				

**TABLE E-5 (continued)**

Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Copenhagen University Hospital of Hvidovre, Denmark						
Jensen et al. <sup>64</sup> (2006)	HSS	Radiolucency, implant survival, complications, ROM, cement technique			Satisfaction	
Royal Liverpool University Hospital, Liverpool, England						
Kalogrianitis et al. <sup>57</sup> (2008)	MEPS, LES	Radiolucency, complications	Pain VAS			
Melbourne Shoulder and Elbow Center, Melbourne						
Kelly et al. <sup>38</sup> (2004)	MEPS	Radiolucency, implant survival, complications, ROM			Satisfaction	
Sunderland Royal Hospital, Sunderland, UK						
Khatri and Stirrat <sup>65</sup> (2005)	Unique	Radiolucency, implant survival, complications				
Maasstad Hospital, Rotterdam, The Netherlands						
Kleinlugtenbelt et al. <sup>36</sup> (2010)	MEPS	Radiolucency, implant survival, complications				
Charles University, Prague, Czech Republic						
Landor et al. <sup>39</sup> (2006)	MEPS	Radiolucency, implant survival, complications, ROM			Satisfaction	
Tan Tock Seng Hospital, Singapore						
Lee et al. <sup>9</sup> (2005)	MEPS	Complications, ROM			Satisfaction	
Lee et al. <sup>40</sup> (2006)	MEPS	Complications, ROM			Satisfaction	



TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Nuffield Orthopaedic Centre, Oxford, England Little et al. <sup>76</sup> (2005)		Radiolucency, implant survival, complications, ROM	Self-rated pain level (classified as none, mild activity-related pain that did not interfere with function, moderate activity-related pain that interfered with function, or severe)			
Northwick Park Hospital, London, England Malone et al. <sup>41</sup> (2004)	MEPS	Radiolucency, implant survival, complications, ROM				
University of Toronto, Canada McKee et al. <sup>7</sup> (2009)	MEPS	Radiolucency, implant survival, complications, ROM		DASH		
Florida Orthopaedic Institute, Temple Terrace, Florida Mighell et al. <sup>66</sup> (2005)	ASES	Radiolucency, HO, bushing wear, implant survival, complications, ROM				
Sagamihara Hospital, Sagamihara City, Japan Mori et al. <sup>8</sup> (2006)	MEPS	Radiolucency, complications, ROM				

TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
University Hospital, Aarhus, Denmark						
Ovesen et al. <sup>58</sup> (2005)	MEPS, unique scale	Radiolucency, implant survival, complications, ROM, strength			Satisfaction	
Snefttrup et al. <sup>59</sup> (2006)	MEPS, ASES	Radiolucency, bushing wear, implant survival, complications, ROM				
Thillemann et al. <sup>42</sup> (2006)	MEPS	Radiolucency, implant survival, complications, ROM				
Stanford Medical Center, Palo Alto, California						
Patil et al. <sup>43</sup> (2009)	MEPS	Radiolucency, implant survival, complications				
University Hospital of Wales, Cardiff, Wales						
Prasad and Dent <sup>44</sup> (2008)	MEPS	Radiolucency, implant survival, complications			Satisfaction	
Prasad and Dent <sup>45</sup> (2010)	MEPS	Radiolucency, implant survival, complications, ROM	Pain VAS		Satisfaction	
Northern General Hospital, Sheffield, UK						
Qureshi et al. <sup>46</sup> (2010)	MEPS	Radiolucency, implant survival, complications, ROM				
University of Turku, Paimio, Finland						
Rauhaniemi et al. <sup>47</sup> (2006)	MEPS	Radiolucency, ROM	Pain VAS		Satisfaction and improvement of function (very, slightly, no effect, worse)	

TABLE E-5 (continued)						
Institution & Study	Aggregate Scale	Level 1	Level 2	Level 3	Level 4	Level 5
		Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
University of Florida, Gainesville						
Renfree et al. <sup>60</sup> (2004)	HSS, Bryan-Morrey	Radiolucency, graft incorporation			Subjective overall score by patient (good, fair, poor)	
Brigham and Women's Hospital, Boston, Massachusetts						
Ring et al. <sup>48</sup> (2005)	MEPS	Implant survival, complications, ROM				
Shi et al. <sup>49</sup> (2007)	MEPS	Radiolucency, implant survival, complications, ROM				
Leiden University Medical Center, Leiden, The Netherlands						
Roziing and Nagels <sup>67</sup> (2008)	Unique scale (pain, function, motion)	Complications				
van der Lugt et al. <sup>68</sup> (2004)	Unique scale	Implant survival, complications, ROM				
van der Lugt et al. <sup>61</sup> (2004)	Unique scale	Radiolucency, implant survival, complications, ROM				
van der Lugt and Roziing <sup>69</sup> (2006)	Unique scale	Radiolucency, implant survival, complications, ROM				
University of Zurich Balgrist, Switzerland						
Schneeberger et al. <sup>50</sup> (2007)	MEPS	Radiolucency, implant survival, complications, ROM			Subjective score (much better, better, same, worse)	
Helsinki University Central Hospital, Hus, Finland						
Skyttä et al. <sup>77</sup> (2008)		Radiolucency, implant survival, complications, ROM	Pain, ulnar nerve symptoms	Ability to do specific tasks	Satisfaction	

		Level 1	Level 2	Level 3	Level 4	Level 5
Institution & Study	Aggregate Scale	Biological & Physiological Variables	Symptom Status	Functional Status	General Health Perceptions	Overall Quality of Life
Nippon Medical School, Tokyo, Japan						
Tachihara et al. <sup>70</sup> (2008)	Unique scale (pain, daily function, ROM, stability, deformity)	Radiolucency, implant survival, complications				
Sapporo Gorinbashi Hospital, Hokkaido, Japan						
Tanaka et al. <sup>51</sup> (2006)	MEPS	Radiolucency, implant survival, complications				
Dogo Spa Hospital, Ehime, Japan						
Tomita et al. <sup>52</sup> (2007)	MEPS	Implant survival, complications, ROM				
Maartenskliniek, Nijmegen, The Netherlands						
van der Heide et al. <sup>71</sup> (2007)	EFA	Radiolucency, implant survival, ROM				
Nottingham Shoulder & Elbow Unit, Nottingham, England						
Vrettos et al. <sup>78</sup> (2005)	Note: Shoulder Constant score for ipsilateral total shoulder arthroplasty	Complications, ROM				
*HSS = Hospital for Special Surgery scoring system, HSS2 = Hospital for Special Surgery Total Elbow scoring system, EFA = Elbow Functional Assessment, LES = Liverpool Elbow Score, MEPS = Mayo Elbow Performance Score, ASES = American Shoulder and Elbow Surgeons elbow assessment fosrm, ROM = range of motion, DASH = Disabilities of the Arm, Shoulder and Hand questionnaire, VAS = visual analog scale, and HO = heterotopic ossification						