The use of the Upper Limb Impairment Calculator

This app is an aid for doing the calculations for the assessment of impairment of the upper limb, based on the 4th or 5th Editions of the AMA Guides to Evaluation of Permanent Impairment (Guides). (The more frequently utilised term limb is used, rather than extremity in this app).

4th and 3rd Editions.
The 4th Edition is still mandated in some places and some situations, as is the 3rd. While most of the comments here refer to the 5th Edition there are, in fact, few differences between the editions, such as radial abduction at the base of the thumb that the app takes into account. There are also differences in assessing things such as scapholunate dissociation but this does not influence the calculations.

Disclaimers

1. This app is a computer program and as such is liable to program errors some of which may be unique to an individual device.

2. This app is a calculator. To use it requires a thorough working knowledge of the relevant AMA Guides to Evaluation of Permanent Impairment. It is not a substitute for that knowledge.

3. Because the app uses the combining formula: A combined with B = A+(1-A)*B, on occasions, results at variance with those obtained by using the Combined Values Chart in the Guides may occur (see below).

4. The following instructions should be read before using the app to avoid user errors.

The creator and the developers take no responsibility for errors that may occur from the use of this app or events that arise from those errors.

What it does.

1. It automates impairment calculations for range of joint movement.

2. It provides an accurate method of calculating impairment due to amputation.

3. It provides related method for calculating sensory loss in the digits and compensates for amputation in the presence of sensory loss.

4. It does the combinations and additions of impairments necessary and provides, automatically, the digit, hand, upper limb and whole person impairment as it goes.

5. It produces a summary of the values entered and the impairments derived including correction for less than normal range of motion in the contralateral uninjured joint.

What it does not do.

1. It does not provide a substitute for a working knowledge of the relevant chapters in the Guides.

2. It does not provide a method of automating the calculation of the various peripheral nerve (16.5 in the 5th Edition) or peripheral vascular impairments (16.6 in the 5th Edition). These are too complex to derive an automated method. However, once these values are entered in the appropriate place they will be automatically combined with the other values, if any.

3. Similarly it does not provide an automated method of calculating impairment due to various other upper limb afflictions (16.7 in the 5th Edition). These values must be sought in the Guides.

4. It does not make a line on the amputation or sensory loss pictures, this is too inaccurate using the iOS system. This can be done manually on a printed summary if desired.

5. Other things such as scarring need to be sought in the relevant chapter of the Guides and entered where appropriate. Once again, when entered the combination calculation is automatic.
Combining.

The combining of values is done following the formula $A_{combined} = A + (1-A)\times B$. This means that the results are the same regardless of order in which they are entered. Using the combining chart at the back of the Guides can produce different results depending on the order in which they are entered. The instructions at different places in the Guides are somewhat ambiguous on this, although some local jurisdictions do mandate largest to smallest. On rare occasions a result different from that would have been obtained from the chart occurs. Over a considerable number of cases this has never been more than 1% either way and is very uncommon.

This matter was the subject of test case in Victoria, Australia, and the judge felt that the formula overrides the chart. Worksafe Victoria have since produced a spreadsheet to do the combination calculations which is available on their website.

General features.

The app works by selecting a series of screens. The first screen is for the patient details, which are entered by tapping on the various categories and typing in the details using the popup keyboard. The date of birth is entered by using the standard iPhone/iPad/iPod wheels. All categories must be filled before the app allows one to proceed to entering values.

The injured part is then selected and once that is done click the Back and then Next. One is then taken through a series of screens, commencing with joint movements, then amputation, sensory loss and other afflictions. The next line or screen is reached by clicking Next and the previous screen by clicking Back. The summary can also be displayed at any time by clicking the Summary at the top right. The appropriate values are entered as one goes and the impairment is calculated and shown on the screen. A pie-chart at the top right hand side indicates the percentage of the task completed for that part.

Once one gets to the end of one part, on the next screen one is invited to add another body part and so start the process again until all impairments are dealt with.

The app produces a summary that may be saved on the device or iCloud and which also may be exported by email as a PDF file.

The summary differs substantially from that in the Guides in several ways. Only injured parts occur in the summary so if only the thumb is involved, for example, only the thumb will appear along with the Hand Impairment Summary. Not only the injured part impairments are displayed but the uninjured and corrected values also are shown. Both the latter will be blank if not relevant.

Amputations.

While it would seem that calculating the impairment value for an amputation should be straightforward, it is not easy to extrapolate from a patient's digit to the drawings on page 443 in the 5th Edition of the Guides, even with an x-ray. The method used here compares the length of the remaining phalanx to that of the uninjured other side. This is relatively straightforward as for any phalanx there is a straight-line relationship between the length of the remaining phalanx and the impairment (see figures 16.4 and 16.5, 5th Edition Guides)

To do this select the appropriate phalanx, measure the length of the amputation stump and enter the value on the screen. Similarly measure the same phalanx on the uninjured side and enter that value and the impairment will be automatically generated.
With the thumb there is a choice of No amputation/distal or Proximal. If the latter is selected then the next screen gives a choice of 36, 37, or 38% and this is automatically put into the Upper Limb Impairment. As the Guides give no guidance about whether or not the first CMCJ should be taken into account in these proximal amputations the screens for that joint have been left in as it could be argued either way.

With major upper limb amputations, because they are uncommon, the values are derived from the Guides and entered by the user toward the end of the screens, under Impairments I, Amputation (other than digit). If there is a proximal amputation then for body part select Other. If it is thought that there may be an impairment due to joint stiffness, in addition to the amputation do the joint calculations first, then when asked to add another body select Other. A simple Excel spread-sheet to automate these major upper limb amputations will be put on the website in due course but the rarity of the situation made it unwarranted for the app.

**Sensory loss.**

Assessment of sensory loss is difficult and the use of two-point discrimination, as suggested in the Guides may be criticised, however that is what is mandated and widely used.

As sensory loss impairment is based on a percentage of the amputation values that approach is used in this app. The site of the divided nerve or proximal level of the sensory loss is entered as Level, as if it were an amputation stump, and compared to the Phalanx Length on the Sensation Radial and/or Sensation Ulnar screens. Complete or Partial is selected and the sensory impairment calculated. (Complete is used here rather than total as in the Guides). The Total sensory loss impairment is displayed on the final sensory screen.

**Sensory loss in the presence of amputation.**

There are sometimes situations where there has been a partial amputation as well as sensory loss. For example, the distal half of the terminal phalanx of a digit may be amputated and the rest of the volar surface has been replaced with a flap or graft that has reduced sensation. Obviously there can be no sensory impairment for a part that is missing, as it is already taken into consideration in the amputation. In this situation, calculate the amputation as outlined above. The sensory loss is calculated ignoring the amputation using the uninjured phalanx length if the sensory loss is confined to the amputated phalanx. If the sensory loss extends more proximal than the partially amputated phalanx then use the length of the phalanx. Tap Correct for amputation on the final sensation screen and the corrected value is obtained. What is occurring in the background is that the sensory component of the amputated part, matched partial or complete, is subtracted from the overall sensory loss.

**Joint motion.**

**Conventions for entering joint motion.**

The Guides are said to base the range movement of joints on the anatomical position being neutral or 0°, which is what is done in this app.

The way most people enter the range of motion in their records is, for example, PIPJ 20-85. This means there is an extensor lag of 20° and it flexes to 85°. Thus, in this app flexion would be entered as 85 and extension as 20, not as -20 as is done for example on page 515 in the 5th Edition of the Guides.

If a digital joint extends beyond neutral, then that is entered as a negative value rather than with a plus sign, as suggested on page 451, Fig.16-9, in the 5th Edition of the Guides for the MCPJ. This is because mathematically x and +x have the same meaning.

Because this program is based on mathematical formula, certain other values must be written as a negative. These are values that are on the other side of neutral or 0°. For example, in a wrist that does not extend beyond
10° of flexion, extension would be entered as -10°. **When there is an ankylosis arbitrarily one side of neutral is entered as a negative value and these are wrist extension and radial deviation, supination, shoulder extension, adduction and external rotation.**

The finger MCPJ are allotted an impairment value for not extending beyond neutral but the PIPJ and DIPJ do not. This seems anomalous; as it is unlikely there is a functional impairment in a MCPJ that extends to neutral and not beyond, concert pianists and Balinese dancers excepted. This is however what the Guides require and is followed here. (See note on uninjured side). Again MCPJ hyperextension is entered with a negative sign not a plus sign.

Ankylosis is no movement and therefore extension and flexion are the same. If there is solid ankylosis enter the Ankylosis value. If there is a small amount of movement use separate flexion and extension values.

**First carpometacarpal movement.**

In the 5th edition of the, Guides radial abduction is treated much the same as flexion and extension of the digits, with values each for radial abduction and lack of radial adduction (see Fig.16-16 and Table 16-8a). This is not reflected in the Upper Extremity Evaluation Record on page 438 of the 5th Edition of the Guides, where only one value is allowed for radial abduction or one for ankylosis. This is likely a hangover from previous editions. This program allows for both radial abduction and radial adduction to be entered if one is using the 5th edition and only one value if using the 4th or 3rd.

Taking into account of the uninjured values outside the normal range.

There is advice, on page 453, in the 5th Edition of the Guides, about the necessity to take into account the situation where the individual has a lesser range of motion in the uninjured contralateral joint than the normal values given in the Guides. This is dealt with in this app by clicking Yes on the Uninjured Data screen, which occurs after the last digit and upper limb joint screens, and then entering the range of movement values for the uninjured joints. If this is done then the adjustment is made and is shown in the summary.

This is particularly useful in the basal joint of the thumb and the MCPJ of the fingers where it seems that many do not have the ranges that the Guides suggest. It is also useful in those who have intrinsically stiff joints for any reason.

**Impairment due to other disorders.**

This section, 16.7 in the 5th Edition of the Guides, deals with a range of problems and is divided into; 16.7a, bone and joint deformities; 16.7b, arthroplasty; and, 16.7c, musculotendinous impairments. These do not lend themselves to automation because the rules are quite complex. These values must be obtained from the appropriate figures or tables and input by the user. There is space for explanatory notes to be entered.

**Peripheral Nerve and Peripheral Vascular Impairments**

Peripheral nerve injury impairments are dealt with in 16.5 in the 5th Edition of the Guides and, include pain syndromes. The subject is too complex to allow automation to be done. Once you have derived the impairment from the tables in the Guides it is entered in the Impairment III screen and it is automatically combined with any other values.

Similarly, peripheral vascular impairments are not automated and have to be derived from 16.6 in the 5th Edition of the Guides. The values are entered at Impairment IV on the next screen.

Both of these allow explanatory notes to be written which will appear in the final report.

**Other disorders (not included in regional impairment)**

The final screen is, Other disorders (not including regional disorders), Impairment V. This, as the guides state, is for other thing such as scarring that must be derived from other chapters. These are entered and the app combines them with the other values.
Saving and sending the information

Once all the data is entered the final screen is reached. One may tick the Sync with iCloud so that the report may be accessed at a later date. If the user is not connected to iCloud a copy will be saved on the device. A copy of the report may be emailed to the user or third parties.

Feedback

This app has been thoroughly tested by us but it is impossible to have tested all combinations and permutations of possible impairments so errors may occur, although we think it is unlikely. Feedback, both positive and negative would be appreciated; in particular errors encountered will be investigated. Also, features the user may like to be incorporated will be considered.