



**Bone & Joint**  
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## **Supplementary Material**

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# 1<sup>st</sup> round of Delphi Process BHS Revision Hip Complexity Classification (RHCC)

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The BHS wishes to produce a comprehensive complexity classification for revision hip. The purpose of this is to provide a comprehensive consideration of pertinent factors that determine complexity in revision to allow improved communication and decision making within networks.

This will be achieved by a modified Delphi process which gives a group of experts equal voice in expressing their opinion.

Our goals are that the RHCC should:

1. Be simple to use
2. Have a graded level of complexity
3. Identify factors that carry greater weighting
4. Utilise established classification systems whenever appropriate, for e.g. Acetabular/Femoral Defect, Host factors (local or systemic), periprosthetic fracture etc.
5. Have good inter and intra-observer reliability

This is the first round of the Delphi process and aims to identify:

1. All factors that are relevant to decision making including surgical, implant factors or host factors (local and systemic) and geographical.
2. Factors that should be given greater weighting than others and escalate the grade of complexity
3. Preferred preoperative classification systems that are used frequently in surgical planning (rather than for research purposes)
4. Expert opinion whether RHCC should mirror Revision Knee Complexity Classification (RKCC)(1)

Please consider factors from all aspect of your practice, particularly with local geographical issues, as well as various aspects encompassed within the realm of revision total hip replacement that you consider would influence the management of these patients.

Thank you very much for your contribution.

Yours Sincerely,  
RHCC Steering Committee

## Questionnaire

1. Please list up to 10 factors (both local to hip and systemic) that you deem important in governing the complexity of revision total hip replacement (RTHR). Please rank these in order of importance
  - a. Any comments regarding factors listed and how it should affect complexity grading (Free comment box)
2. For each of the factors you have listed in 1, please indicate the classification system (if any) that you use in clinical practice.
3. How many grades or levels of complexity should the final classification contain to balance simplicity and usefulness?
  - a. 3
  - b. 4
  - c. More than 4
4. Do you think all cases should be discussed at a regional MDT meeting?
  - a. Yes/No
  - b. If No, what factors would identify a case for local decision making and treatment without the need for regional MDT discussion? (free text)
  - c. Do you think a RHCC should act as a triage tool for referral to a regional MDT for discussion?
    - i. Yes/No
    - ii. comments
  - d. Do you think a RHCC could provide a useful reference for discussion for management of revision hip arthroplasty cases in a regional network?
    - i. Yes/No
    - ii. comments
5. Do you have any previous experience of using the Revision Knee Complexity Classification (RKCC)(1) as part of your revision practice?
  - a. Yes/ No
  - b. If Yes, do you find it helpful (Yes/No)
    - i.If Yes, how do you find it helpful?
    - ii.If No, why?
  - c. Do you think RHCC should mirror RKCC in terms of number of levels (3)?
    - i. Yes/ No
  - d. Any other comments?

6. Any other comments on the process?

## **Reference**

1. Phillips JRA, Al-Mouazzen L, Morgan-Jones R, Murray JR, Porteous AJ, Toms AD. Revision knee complexity classification—RKCC: a common-sense guide for surgeons to support regional clinical networking in revision knee surgery. *Knee Surg Sports Traumatol Arthrosc* [Internet]. 2019 Apr [cited 2020 Apr 7];27(4):1011–7. Available from: <http://link.springer.com/10.1007/s00167-019-05462-x>

# 2<sup>nd</sup> round question Delphi process BHS Revision Hip Complexity Classification

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Thank you for your involvement in the Delphi study. During our first round Delphi process, we have achieved a very strong consensus (94%) that the RHCC will provide useful reference for discussion for management in regional network. We proposed classification with three categories (H1, H2 and H3) to mirror RKCC classification to help with uniformity across revision network and simplicity of classification system.

During this round, we will delve deeper into deciding how much each factor will affect the complexity of a particular case by categorising them into each section of the classification system.

1. We have a strong consensus (75%) that Paprosky classification is used to quantify amount of bone loss. Please decide which type of Paprosky classification belong to revision category H1, H2 and H3.
  - a. Acetabulum (Please ensure you rank all classification category only once (I, IIa, IIb, IIc, IIIa and IIIb) into either H1, H2 or H3)

| Type | Relationship of component to the Köhler line | Vertical migration | Ischial lysis | Tear drop |
|------|--|--------------------|---------------|-----------|
| I    | lateral                                      | minimal            | minimal       | intact    |
| IIa  | medial                                       | minimal            | minimal       | intact    |
| IIb  | lateral                                      | approaching 2 cm   | minimal       | intact    |
| IIc  | medial                                       | minimal            | minimal       | violated  |
| IIIa | lateral                                      | > 2 cm             | mild/moderate | intact    |
| IIIb | line violated                                | > 2 cm             | severe        | violated  |

Type I indicates an intact and supportive acetabular rim, with no migration of the component, no evidence of osteolysis in the ischium or tear drop and no violation of the Köhler line.

Type II indicates adequate host bone remaining to support a cementless acetabular component and > 50 % host bone support, with < 2 cm or superior migration of the hip centre from superior obturator line and no major osteolysis of the ischium or tear drop (ischial osteolysis of < 7 mm below the obturator line).

Type IIIa indicates > 2 cm of superior and lateral migration of the component above the obturator line with mild to moderate ischial lysis. The component is at or lateral to the Köhler line and the ilioischial and iliopubic lines are intact. The failed component migrates superiorly and laterally.

Type IIIb indicates more extensive ischial osteolysis (> 15 mm below the obturator line), complete destruction of the tear drop, migration medial to the Köhler line, and > 2 cm of superior migration of the component cephalad to the obturator line. The failed component migrates superiorly and medially.

H1:

H2:

H3:

- b. Femur (Please ensure you rank all classification categories only once (I, IIa, IIb, IIc, IIIa, IIIb and IIIc) into either H1, H2 or H3)

TABLE V  
CLASSIFICATION OF BONE LOSS ACCORDING  
TO THE SYSTEM OF PAPROSKY ET AL.<sup>55</sup>

| Type | Metaphysis                                   |                     | Diaphysis |
|------|--|---------------------|-----------|
|      | Medial                                       | Lateral             |           |
| 1    | Minimum damage                               | Intact              | Intact    |
| 2A   | Loss to level of lesser trochanter           | Intact              | Intact    |
| 2B   | Loss to level of lesser trochanter           | Deficient           | Intact    |
| 2C   | Damage extending into subtrochanteric region | Intact              | Intact    |
| 3A   | Loss to level of lesser trochanter           | Intact              | Damaged   |
| 3B   | Loss to level of lesser trochanter           | Deficient           | Damaged   |
| 3C   | Damage extending into subtrochanteric region | Intact or deficient | Damaged   |

H1:

H2:

H3:

2. Please group each Vancouver Classification and factors related to periprosthetic fracture into revision categories (H1,H2 and H3)

(Please ensure you rank all classification category only once (A, B1, B2, B3 and C) into either H1, H2 or H3)

H1:

H2:

H3:

- a. Revision of periprosthetic fracture around revision implant  
b. Revision of acetabular periprosthetic fracture

3. Please consider factors below and place them into revision categories (H1,H2 and H3)
  - a. DAIR
  - b. Revision for infection
  - c. Revision for atypical organism (Fungal, Tuberculosis or Multidrug resistant organism)
  - d. Re-revision for infection

H1:

H2:

H3:

4. Please consider soft tissue factors listed and place them into revision categories
  - a. Abductor muscle compromise
  - b. Severe shortening (>5cm)
  - c. Skin compromise needing plastic surgical intervention
  - d. High risk for neuro-vascular injury

H1:

H2:

H3:

5. Please consider patient factor as per ASA classification and place them into revision categories (H1, H2,H3)

| ASA PS Classification | Definition   | Adult Examples, Including, but not Limited to:   |
|-----------------------|--|--|
| <b>ASA I</b>          | A normal healthy patient   | Healthy, non-smoking, no or minimal alcohol use  |
| <b>ASA II</b>         | A patient with mild systemic disease                                     | Mild diseases only without substantive functional limitations. Current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease   |
| <b>ASA III</b>        | A patient with severe systemic disease                                   | Substantive functional limitations; One or more moderate to severe diseases. Poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, history (>3 months) of MI, CVA, TIA, or CAD/stents. |
| <b>ASA IV</b>         | A patient with severe systemic disease that is a constant threat to life | Recent (<3 months) MI, CVA, TIA or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, shock, sepsis, DIC, ARD or ESRD not undergoing regularly scheduled dialysis  |

H1:

H2:

H3:



## 3<sup>rd</sup> round Delphi - BHS Revision Hip Complexity Classification (RHCC)

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Thank you for all your prompt participation so far. We are pleased to say that a strong consensus has been achieved in many areas. In most circumstances the complexity for each case are multifactorial. However, we would be grateful if you could consider each factor independently as much as you can in order to decide how each factor affects the complexity of a case in the absence of other issues.

We would also like to take this opportunity to emphasise that the current process is purely about developing a classification for grading of complexity of revision procedures rather than decisions around where management should take place.

During the 3<sup>rd</sup> round, we will be looking into areas where only a weak consensus or simple majority has been seen so far. The aim is to try and achieve a stronger consensus for the final classification. There are also a number of other issues that have been raised that we will ask you about.

### Level of consensus

- Simple Majority (no Consensus 50.1-59%)
- Majority: Weak Consensus (60-65% agreement)
- Super Majority: Strong Consensus (66-99% agreement)
- Unanimous: 100% agreement

Throughout this questionnaire, we will be showing you the result of 2<sup>nd</sup> round Delphi survey. We have also highlighted some of the comment the expert panel have made about each topic and in some instances provided some evidence around incidence and outcomes. Please use these to guide your decision making.

Thank you.

## 1. Bone Loss (acetabulum)

|                      | H1- | H2- | H3-  |
|----------------------|-----|-----|------|
| I                    | 97% | 3%  | 0%   |
| Ila                  | 77% | 20% | 3%   |
| Ilb                  | 40% | 57% | 3%   |
| Ilc                  | 12% | 74% | 14%  |
| IIIa                 | 0%  | 37% | 63%  |
| IIIb                 | 0%  | 11% | 89%  |
| Pelvic Discontinuity | 0%  | 0%  | 100% |

### Summary:

We have achieved a strong consensus for I, Ila, Ilc, IIIb and pelvic discontinuity. Ilb and IIIa remain in question.

### Evidence

Paprosky et al (2013) proposed that IIB should be managed with a porous hemispherical implant with the use of adjunctive screw fixation to achieve initial stability. Della Valle et al has reported a cohort of 138 hips with a cup survivorship of 96% at a mean of 15 years follow up when uncemented hemispheric cup was used for Type I and II defects.(1)

IIIa defect are generally managed with uncemented or cemented acetabular component along with supplemental porous metal augments, rim mesh or structural graft. Sporer and Paprosky reviewed the outcome of 28 patients managed with trabecular metal acetabular component and augment. There was only one patient required re-revision for recurrent instability at 3 years.(2)

Chacko et al reported outcomes of 146 revision hip replacements using high friction metal acetabular component in reconstruction of acetabular defects. They identified 71 (49%) Grade II defect (2A [28], 2B [19], 2C [24]) and grade 3 in 20 (14%) (3A [18], 3B [2]) The survivorship for all-cause failure was 95.8% and the survivorship for aseptic loosening was 98.6%. at 43.5 months follow-up. (3)

Van Kleunen et al evaluated 97 hips with Paprosky II, IIIA and IIIB defects that were managed with uncemented acetabular shells with augments and found no cases of aseptic loosening at a mean follow up of 45 months. (4)

Borland et al also evaluated 24 revisions(15 grade IIIA, 9 Grade IIIB) using porous trabecular metal augments with impaction bone grafting and cemented acetabular component. At 2 years 23 patients had improved PROMS and very satisfied. 1 patient undergone further re-revision and was found to have a fractured augment at revision. (5)

**Comments from round 2:**

“Intraoperative findings are often much worse than one can anticipate looking at preop radiology quality should also matter, ie known osteoporosis”

“Need to appreciate when Paprosky classification will let you down (eg. Major bone loss when implant migration has not occurred- eg massive osteolysis in well-fixed components)”

“Higher grade recon can result from poor implant removal and underappreciated bone loss, eg removal of well-fixed uncemented socket with severe lysis

**Questions:**

- a. IIb grade (Up and out with <2cm migration). There is a simple majority (57%) that IIb should be in H2.

**Please classify IIb as H1/H2/H3**

- b. IIIa grade (up and out with >2cm migration). We have achieved weak consensus (63%) that IIIa should be classified to H3.

**Please classify IIIa as H1/H2/H3**

- c. Paprosky classification takes no account of lysis around well fixed implants.

**How would you classify a well-fixed socket with >1cm of lysis extending into the ischium, pubic ramus or ileum? H1/H2/H3**

**Should we include this in the classification? Yes/No**

## 2. Bone Loss (femur)

|      | H1  | H2  | H3  |
|------|-----|-----|-----|
| I    | 97% | 3%  | 0%  |
| II   | 46% | 51% | 3%  |
| IIIa | 6%  | 74% | 20% |
| IIIb | 0%  | 31% | 69% |
| IV   | 0%  | 9%  | 91% |

### Summary

We have achieved strong consensus for I, IIIa, IIIb and IV. II remains in question

### Evidence

Valle et al reported the algorithmic approach to reconstruct femoral defects according to the Paprosky classification (Valle et al, 2003). Out of 71 consecutive femoral revisions 29 were type II (40%). In these cases, reconstruction was carried out using extensively coated diaphyseal fitting stem. Satisfactory osteointegration of the stem was reported in 26 out of 29 (89.6%) cases. (6)

Wilson et al reported outcomes of femoral impaction bone grafting in 705 revisions with a mean follow up of 14.7 years. 76 re-revisions (10.8%) involving the stem occurred for aseptic loosening (7), perioperative fracture (23), malposition (1), fractured stem (1), and in cement revision during acetabular revision (19).(7)

### Comments from round 2

“Somehow need to grade difficulty of any ETO - ie removing a Furlong is not the same as ETO’ing a cemented stem!”

### Questions:

- a. There is a simple majority that II (extensive loss of metaphyseal bone with intact diaphysis) should be in H2 (51%)

#### **Please classify IIb as H1/H2/H3**

- a. Paprosky classification takes no account of removal of implants. Removal of well-fixed, metaphyseal filling uncemented implants (eg Furlong) is undoubtedly complex.

**How would you classify a well-fixed, metaphyseal filling uncemented implants (eg Furlong) which may require removal? H1/H2/H3  
Should we include this in the classification? Yes/No**

### 3. Periprosthetic fracture

|   | H1  | H2  | H3  |
|---|-----|-----|-----|
| A   | 89% | 9%  | 3%  |
| B1  | 49% | 51% | 0%  |
| B2  | 12% | 74% | 14% |
| B3  | 0%  | 37% | 63% |
| C   | 43% | 43% | 14% |
| Revision of periprosthetic fracture around revision implant | 0%  | 14% | 86% |
| Revision of acetabular periprosthetic fracture              | 0%  | 17% | 83% |

#### Summary

We have achieved strong consensus for A, B2, B3 as well as the specific issues of fracture around a revision implant and acetabular fracture. However, multiple comments have been made about moving to the Unified Classification System (UCS) to seek clarifications about more complex scenarios.

We also wish to seek clarification and consensus around B1 and C. A number of surgeons mentioned that these fracture are treated with ORIF rather than revision however there is always the potential to require revision surgery should the stem/cement be shown to be loose intraoperatively.

#### Comments from round 2

- ‘A’ fractures rarely need fixing, B1 and C would normally be fixed not revised. B type fractures around taper slip stems are often B2 but if the bone cement interface is well fixed and the fracture can be anatomically fixed around the taper slip stem then it should be and does not require revision.
- A, B1 & C are unlikely to even require revision. Might be confusing to include in revision pathway
- Of course, B1 and C will be fixable, so not necessarily meeting the revision complexity classification necessarily.
- B1 has a higher failure rate due to potentially of misdiagnosis of B2 as B1, hence surgeons performing ORIF for B1 should have the ability to perform revision surgery should the implant be found to be loose on table.

#### Questions

- a. Please classify the below:

**UCS B1 - H1/H2/H3**

**UCS C- H1/H2/H3**

**UCS D (fracture between two implants)- H1/H2/H3**

**UCS E (each of two bones supporting an arthroplasty)- H1/H2/H3**

**UCS F (facing an articulation with a hemiarthroplasty – ie an acetabular fracture around a hemiarthroplasty pls note acetabular fracture already classified as H3)-H1/H2/H3**

## 4. Infection

|   | H1  | H2  | H3  |
|---|-----|-----|-----|
| DAIR  | 51% | 43% | 6%  |
| First time revision for infection   | 6%  | 69% | 25% |
| Revision for atypical organism (Fungal, Tuberculosis or Multidrug resistant organism) | 0%  | 11% | 89% |
| Re-revision for infection   | 0%  | 3%  | 97% |

### Summary

We have achieved strong consensus for all groups apart from DAIR (simple majority 51%). There were multiple comments in relation to DAIR; recognising the importance of appropriate expertise and the MDT but not wishing to delay surgery. Again, we wish to highlight that this process is about classifying the complexity of the surgery rather than stipulating where that surgery should be undertaken.

### Evidence

During the International Consensus Meeting in Philadelphia 2019, it was felt that DAIR should be performed within at least seven days, but preferably as soon as possible, after the onset of symptoms. (92% consensus). DAIR in an experienced hands can achieve 10 year implant survivorship of 77%. (8)

### Comments from round 2

- “any infected case by definition is more complex and requires surgical and microbiological experience. For a DAIR to be most effective it needs a radical surgical debridement and expert microbiology input, ideally by a team used to dealing with infection. For the same reason, a first-time revision for infection, which may not require complex bone loss or implants still requires a more experienced team, who manage infection regularly”
- “I have my concerns about who/ where should DAIR be performed. Ideally it should be done in units undertaking revisions in categories H2, or even H3, and by surgeons with a special interest in PJI. However, this would be logistically impossible. Therefore I accept grading DAIR into H1 revision category but suggest that it should be performed by designated surgeons within the spoke units and that these surgeons stay in close contact with their regional hub where they should turn for advice or further their training and where their results should be monitored “



- “Due to logistical issues and acute nature of presentation of patients for DAIR, I felt that in the presence of experienced revision arthroplasty surgeon in a spoke hospital, it is unsuitable to be graded as a higher level as this could result in a desire/pressure to refer on which would institute delay in treatment which could be disadvantageous to the patient’s treatment and outcome. Furthermore, the primary hospital would have the modular component which are required for modular exchange.”

### **Questions**

- a. Putting above comments into consideration, would you consider DAIR to be H1/H2/H3?**

## 5. Soft tissue

|  | H1  | H2  | H3  |
|--|-----|-----|-----|
| No evidence of abductor muscle compromise                    | 97% | 3%  | 0%  |
| Some evidence of abductor compromise                         | 28% | 69% | 3%  |
| Evidence of complete abductor deficiency                     | 0%  | 51% | 49% |
| Case requiring plastic surgical or vascular surgical support | 0%  | 3%  | 97% |

### Summary

We have achieved strong consensus for all groups apart from ‘evidence of complete abductor deficiency’.

### Comments from round 2

- Whilst absence of abductor does increase complexity for a revision case, this is more likely to be dealt with by increasing constraint (dual mobility or constrained liner) rather than complex soft tissue muscle transfers. Hence, I feel that H2 is the appropriate level.
- Abductor compromise can be managed with inventory choice, not complex. No abductors needs v careful consideration of options and this higher experience hence more complex
- Abductor deficiency only H2 for increased constraint requirement.

### Questions

- a. Please classify “Evidence of complete abductor deficiency” as H1/H2/H3

## 6. ASA

|     | H1  | H2  | H3  |
|-----|-----|-----|-----|
| I   | 97% | 3%  | 0%  |
| II  | 71% | 26% | 3%  |
| III | 3%  | 77% | 20% |
| IV  | 0%  | 26% | 74% |

### Summary

We have achieved strong consensus in all ASA groups. ASA III and IV are thought to be of higher complexity

However, there were multiple experts who expressed concerns about comorbidity being an absolute factor.

### Comments from round 2

- For example, a “straight forward” revision such as modular exchange or aseptic loosening (single component) which would otherwise be classified as H1 would be H3 if the patient was ASA IV, which seems illogical
- I wouldn't use this to categorise the complexity of the surgery per se. It could be used as an 'elevator' in terms of ASA and BMI. So ASA 3-5 or BMI over 40 would elevate whatever complexity to the next level, and perhaps independently. So an H1 in a ASA1 BMI 40 pt might become an H2 but an H1 in and ASA 3 BMI 40 might go up two points to H3
- A technically simple revision in an ASA 4 patient would not need doing in a major revision centre so long as the anaesthetic team were experienced and HDU was available.
- the problem here is that medical comorbidities do not always correlate to surgical complexity
- Tough to grade in isolation for ASA3. I think ASA 3 increases grade by one grade i.e. H2 revision but frail ASA3 makes it H3. The ASA frail patient needs an experienced revisionist to minimise the surgical insult. So rather than it being a stand alone indicator of complexity it needs almost to be an additive to grading from the above factors.

## Questions

Based on the available comments, we proposed that patients with ASA III and IV (includes BMI>40) should be considered to be added complexity based on round 2 Delphi. There are two ways to achieve this:

**1) Escalator:** ASA III and IV escalate the complexity. For example, if a patient is otherwise classed as H1, they will be escalated to H2 and H2 to H3.

**2) Qualifier:** Patients with ASA III and IV would have an \* added to their complexity grading such as H1\*, H2\* or H3\*.

This would help identify the underlying surgical complexity with \* being the added patient factor complexity.

**Please choose ASA as Escalator or Qualifier**

## 7. Previous Revisions

|                                   | H1  | H2  | H3  |
|-----------------------------------|-----|-----|-----|
| First time revision               | 80% | 14% | 6%  |
| Re-revision                       | 3%  | 60% | 37% |
| Revision of PFR/TFR               | 0%  | 9%  | 91% |
| 1st time revision for dislocation | 31% | 63% | 6%  |
| Re-revision for dislocation       | 0%  | 37% | 63% |

### Summary

We have strong consensus for first time revision and revision of PFR/TFR.

There were multiple experts who expressed concerns about classifying these factors in isolation. The steering committee agrees that these factors encompass a wide range of issues. However, we would appreciate it if you can consider each factors in isolation as much as possible during your decision making.

### Comments from round 2

- Dislocation depends on whether implant or pt factors. Implant can be H1. Severe pt, such as Neurological better H3
- Each of these factors potentially encompass such a broad range of scenarios that it is hard to assign simply into these categories. A first-time revision could be H3 for other reasons and a re-revision could be simple.
- I firmly think that re-revision is a H3 situation!
- Very difficult to categorise these conditions without the aetiology of what the revision or re-revision is for. A first-time revision can range from H1-H3, re-revision H2-H3, 1st time revision for dislocation H1-H3, Re-revision for dislocation H2-H3.
- first time revisions could be H1,2 or3 depending on the reason and all the other factors above

### Questions

- a. Putting above comments into careful consideration, please classify each factor below into H1/H2/H3.
  - a. Re-revision – H1/H2/H3

- b. Revision of PFR- H1/H2/H3
- c. Revision of TFR- H1/H2/H3
- d. 1<sup>st</sup> time revision for dislocation- H1/H2/H3
- e. Re-revision for dislocation – H1/H2/H3

**8. Would you be interested in participating in an open discussion forum (online virtual meeting) for discussion of the classification and seek final consensus? Yes/No**

**References**

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