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# From Lesion size to Best Response - Implementing RECIST through programming

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## ABSTRACT

RECIST stands for Response Evaluation Criteria in Solid Tumors and serves guidance for assessing tumor shrinkage and disease progression, an important endpoint in many Oncology Clinical Trials. Investigators, cooperative groups, industries, and government authorities use RECIST, first published in 2000. Currently the revised version is RECIST v1.1, published in 2008 (Eisenhauer E.A. et al). This paper looks at RECIST v1.1 from a programmer's perspective to derive the Best Overall Response of a subject using collected Lesion data from across multiple visits in an ongoing study and using SAS® as a programming language.

## 1. INTRODUCTION:

Anyone working in the Pharmaceutical industry conducting Clinical Trials in Oncology, especially if the study is on Solid Tumors, must have heard about the RECIST criteria. It stands for *Response Evaluation Criteria in Solid Tumors* and the current version RECIST v1.1 (*Eisenhauer E.A. et al*). Physicians, statisticians, and scientists use it to assess Response of subjects and ultimately to determine if the study is producing desired outcomes. There could be many possible reasons to derive the Best Overall Response programmatically specially during an ongoing clinical trial. It could be required for presentations at Oncological related conferences, to do additional check on the responses received from an investigator, or to perform interim analyses, evaluate risk: benefit in ongoing trials, based on the efficacy results.

### 1.1 RECIST THROUGH SAS

As a SAS programmer if one needs to write a program that looks at the Lesion size of a subject across visits, and then compute the Best Response based on lesion size using guidelines from RECIST v1.1 then there are many of the accompanying challenges, which comes through. This paper intends to provide a systematic approach to understand the flow and to compute the Best Overall Response for subjects using RECIST guidelines. However, it should be noted that this paper is only intended to provide an Algorithm and a detailed process flow to derive the Best Overall Responses from the Lesion data and cannot cover the full Program for deriving the afore-mentioned. However, algorithm as well as any special notes are discussed in detail and snippets from parent program are added for tricky pieces, wherever needed.

### 1.2 UNDERSTANDING RECIST:

From now on, any reference of RECIST in this paper would mean RECIST v1.1 and rules and guidelines as mentioned and published in the paper "*New response evaluation criteria in solid tumours: Revised RECIST guideline (version 1.1)"* in the European Journal of Cancer in 2008 (*Eisenhauer E.A. et al*). It is a complex paper written by many associations from across the world, which talks about how to calculate Best Response of subjects having solid tumors in a clinical trial. Any programmer who has attempted or is attempting to write a robust code would need to go through this paper thoroughly before they can start programming the data. In addition, if a programmer has gone through this already – they already know that there is a lot to process from this paper, and it does require a lot of skimming and repeated reading to extract the important information from the paper, which would be useful for a programmer. Also, it should be noted that this paper cannot cover all horizons of the RECIST paper, but it merely serves as a guidance for SAS Programmers trying to write their own piece of Standard RECIST program as per the

company requirements and the protocol. Last but not the least, a reading of RECIST v1.1 paper is highly recommended to gain a better understanding of discussed principles.

### 1.3 UNDERSTANDING DATA:

#### 1.3.1 Structuring Raw Data in a Standard Format

Lesion size, its' anatomical location, characteristics (Target or Non-Target) and other details as collected and required by the study Protocol, makes the raw data. Therefore, one needs to know what is most commonly collected (and needed for programming). All measurable and non-measurable tumors identified at the Baseline visit characterized as "Target" and "Non-Target" by the investigator. Any New Lesion seen after Baseline is considered as "New Lesion".

Usually, if there are many measurable lesions, the investigator needs to determine a maximum of five lesions (a maximum of only 2 per organ) as Target, and the rest are identified as Non-Target. In addition, if it is a Target Lesion, size of the lesion should be present (as per RECIST), although for a non-target, it may or may not be recorded in studies.

Once the data is collected, it should be structured and formatted to adapt to our programming needs. Although one might retain more data than listed below, this list comprises the necessary data to continue programming to next steps. Such data is-

- Date of collection
- Visit Id and Visit Names
- Lesion Ids (numbers)
- Lesion (Tumor) Type – *Target* or *Non-target*
- Lesion Site (especially if Lymph Node or Other)
- Short Axis (Diameter) if Lymph Node
- Long Axis (Diameter)

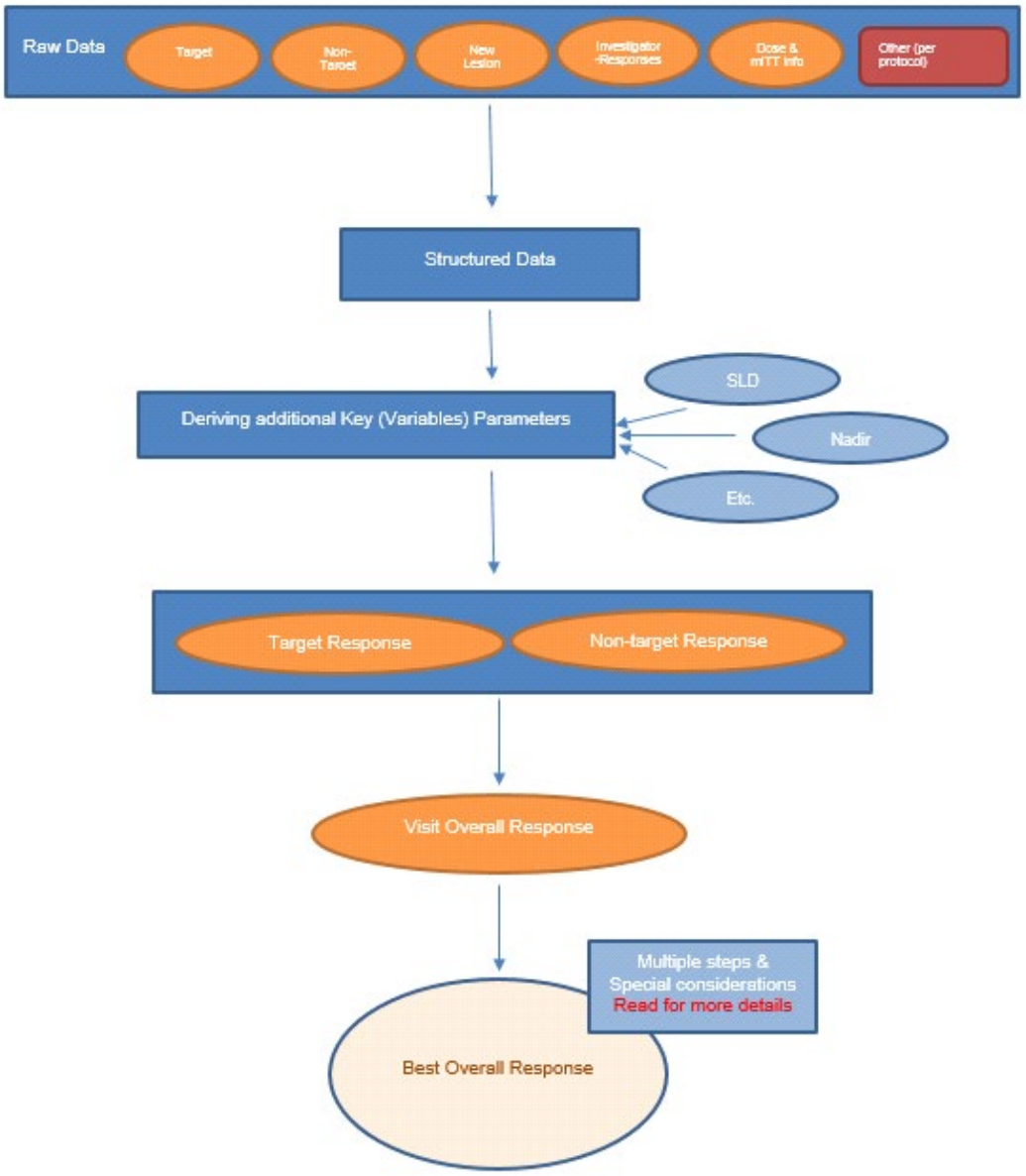
## 2. OUTLINE

Once Data is ready in a programmable format, the whole process of achieving Best Overall Response from the raw data summarized in below steps (also see 2.1 Programming Flowchart):

- Deriving additional required variables
- Target Response
- Non-Target Response
- Visit Overall Response
- Best Overall Response.

For understanding of entire process in detail, let us review the next section, which elaborates each component in more detail.

### 2.1 PROGRAMMING FLOWCHART:




Programming Flowchart: Above flowchart highlights the steps and sources to compute the Best Overall Response.

## 3. THE PROGRAMMING PROCESS:

### 3.1 DERIVING ADDITIONAL REQUIRED VARIABLES:

Before getting to derive Target and Non-Target Response, we need a few more derived variables as given below. These are important in computation and derivation of Target Response for subjects (Also refer Table1 for an example of what sample data might look like after derivation of below parameters).

- Baseline SLD (mm): Sum of all (Target) Lesion diameters at Baseline - This value remains

constant for the subject. Baseline visit is the visit at Baseline {marked by specific Visit numbers and Visit names} as per the given study, typically prior to start of therapy. Any lesions assessed (Target and Non-target) at this visit, will be considered for computations at Baseline. Eg: SLD at Baseline is computed at this visit as Sum of all Target Lesion Diameters (Long or short depending on the Site).

In terms of programming, SLD (Sum of Lesion Diameters) must be first calculated for all Target Lesions grouped by visit, and then SLD specific at Baseline is assigned as Baseline SLD. Also once computed, these records should be retained for all subsequent visits for each subject. An easy way to do this is by using sum statement on Diameters (re-assigned as New Diameter based on site of tumor – Short Diameter Axis for Lymph Nodes and Long Diameter Axis for all other Non-nodal tumors) in proc sql and records grouped by Visit Dates (if each visit is specific for a certain date), and Subject Ids. See code below for example.

```
*************************************************************************;
* Calculating Sum of diameters, and Baseline Sum of diameters           ;
*************************************************************************;
   proc sql;
      /*TO COMPUTE SLD*/
      create table resp1 as
            /*ND -(Short Axis if Site is Lymph Node, else Long Axis)*/
            select * , sum(ND) as SUM_temp label "Sum of Diameters for
            Calculation"
            from tum
            group by ADT, SUBJID ;

    /*TO COMPUTE SLD at BASELINE*/
    create table resp2 as
        select * ,
            case
                  when (TRG = "Target") then SUM_temp
                  else .
            end as SUM,
            case
                  when (VISITID = 2) then calculated SUM
                  else .
            end as B_SUM label "Baseline Sum of diameters"
         from resp1
         order by COHORT, subjid, ADT, VISITID, T_ord, L_id ;
        /*T_ord and L_id used for structuring data*/
        /*T_ord = 1 for Target, 2 for Non-Target, 3 for New Lesion*/
        /*L_id is for sequence of Lesions. Example below:*/
        /*Eg: T1,T2 for Target; NT1,NT2 for Non-Target; Nw1,Nw2 for New
        Lesion*/
   quit;

* TO RETAIN BASELINE SLD for each SUBJECT ;
   data resp4;
      set resp3;
      by subjid ADT VISITID;
      retain BL_SUM ;
      If first.subjid then
      BL_SUM = B_SUM ;

      /*BLS - Baseline SLD*/
      If SUM = . then BLS = . ;
      else BLS = BL_SUM ;
```

```
   run;

*************************************************************************;
*************************************************************************;
```

- Nadir: Lowest SLD recorded up-till (before) the current visit. – This value may (or may not) change at every visit. Nadir would be the lowest record (SLD value) during subjects' visits. Here, the lowest SLD recorded (during all visits) before current visit, since Baseline would be considered the value for Nadir.

  Nadir is a very important parameter for Target Response evaluations. For deriving Nadir – Subject's SLD at every visit is programmatically compared with the SLD at previous visit (refer table1) and lower value between them is selected and subsequently used in the next visit as Nadir.

  One of the ways to do this is by first making sure that the records are sorted in the order of Baseline visit and then the rest of the visits. Now, using retain statement, lag statement, and logical conditions - Nadir is assigned as equal to SLD if visit is Baseline, or temporary variables are created to check the lower value of SLD and then assign the Nadir. See below code for an example.

```
*************************************************************************;
* Calculating Nadir                                                     ;
*************************************************************************;


* Creating temporary test variable for ordering Nadir ;
   data resp5 ;
      set resp4 ;
      /*For Baseline Visits - assign test as 0*/
      If VISITID = 2 then test = 0 ;
      else test = 1 ;
   run;

* Re-sorting data to calculate Nadir ;
   proc sort data = adrs.resp5 ;
      by subjid test ADT ;
   run;

* Computing temporary Nad_1 and Nad_2 variables ;
   data adrs.resp6 ;
      set adrs.resp5 ;
      by subjid test ADT ;
      retain Nad_1 Nad_2 ;
      ************************************;
      If VISITID = 2 then Nad_1 = BL_SUM ;

      If VISITID ne 2 then do ;
/*    For records where visit is other than Baseline ;*/
      If (SUM_temp < BL_SUM) and (Nad_1 > SUM_temp) then nad_1 = SUM_temp ;
      end ;
      ************************************;
      If first.ADT then do ;
            Nad_2 = lag(Nad_1) ;
      end ;

   run ;

* Computing final Nadir based on temp {Nad_1 and Nad_2} variables ;
```

```
   data adrs.resp7 ;
      set adrs.resp6 ;
      If VISITID = 2 then Nadir = . ;
      If VISITID ne 2 then do ;
            /*To assign Nad_2 as final Nadir for visits other than Baseline*/
            If T_ord = 1 then Nadir = Nad_2 ;
            else Nadir = . ;
      end ;
      drop test Nad_1 Nad_2 ;
   run ;
*****************************************************************;
*****************************************************************;
```

- Percent Change from Baseline: defined as Percent Change in SLD from Baseline. Eg: If Baseline SLD is 80, and SLD at Week4 is 60, then Percent Change from Baseline = (60-80/80)100 = -25%. Negative value reflects a 25% decrease from Baseline SLD.

- Percent Change from Nadir: defined as Percent Change in SLD's from Nadir. Eg: If Nadir value is 80 at Week4, and SLD at Week8 is 100, then Percent Change from Nadir at Week8 = (100-80/80)100 = 25%. Positive value reflects a 25% increase in SLD from Nadir (lowest point).

| Subjid | Visit Id | Visit Name | Tumor type | Lesion Id | Lesion Diameter | SLD | Baseline SLD | Nadir |
|---|---|---|---|---|---|---|---|---|
| 101 | 2 | Baseline | Target | 1 | 10 | 30 | 30 | |
| 101 | 2 | Baseline | Target | 2 | 10 | 30 | 30 | |
| 101 | 2 | Baseline | Target | 3 | 10 | 30 | 30 | |
| 101 | 2 | Baseline | Non-Target | 4 | | | | |
| 101 | 2 | Baseline | Non-Target | 5 | | | | |
| 101 | 3 | Week4 | Target | 1 | 8 | 24 | 30 | 30 |
| 101 | 3 | Week4 | Target | 2 | 7 | 24 | 30 | 30 |
| 101 | 3 | Week4 | Target | 3 | 9 | 24 | 30 | 30 |
| 101 | 3 | Week4 | Non-Target | 4 | | | | |
| 101 | 3 | Week4 | Non-Target | 5 | | | | |
| 101 | 4 | Week8 | Target | 1 | 11 | 39 | 30 | 24 |
| 101 | 4 | Week8 | Target | 2 | 15 | 39 | 30 | 24 |
| 101 | 4 | Week8 | Target | 3 | 13 | 39 | 30 | 24 |
| 101 | 4 | Week8 | Non-Target | 4 | | | | |
| 101 | 4 | Week8 | Non-Target | 5 | | | | |

**Table1: Listing of Target and Non-target Lesions**

### 3.2 TARGET RESPONSE:

Target Response of a subject is determined based on increase or shrinkage in Tumor burden (Target Lesions as primary component) and derived as follows, as per RECIST guidelines. In general, to check Target Response for a visit, SLD for that visit is compared with the SLD at Baseline. The following Algorithms have been derived based on section 4.3.1. Evaluation of target lesions from RECIST v1.1 paper (*Eisenhauer E.A. et al*)..

It is' important to note that not only the below logic (based on RECIST v1.1), but the order is also important in determining the below responses. Note: Target Response (TR) are abbreviated to show Complete Response (CR), Partial Response (PR), Stable Disease (SD), Progressive Disease (PD), and Non-Evaluable (NE).

### 3.2.1 Target Response if Lesions Sites are Lymph Nodes:

- If New-Lesions are absent and SLD <=10 then TR = CR

- If New-Lesions are absent and SLD-Nadir >= 5 and Percent Change from Nadir >= 20 then TR = PD

- If New-Lesions are absent and Percent Change from Baseline <= -30 then TR = PR

- If New-Lesions are absent and none of the above conditions are met then TR = SD

- If New-Lesions are present then TR = PD

### 3.2.2 Target Response if Lesions Sites are Non-Nodal (other than Lymph Nodes):

- If New-Lesions are absent and SLD = zero then TR = CR

- If New-Lesions are absent and SLD >= 5 and Percent Change from Nadir >= 20 then TR = PD

- If New-Lesions are absent and Percent Change from Baseline <= -30 then TR = PR

- If New-Lesions are absent and none of the above conditions are met then TR = SD

- If New-Lesions are present then TR = PD

Note: Special conditions (as per protocol) as required for Response evaluation maybe added in this step if required. For example: If the Protocol requires to display the Responses as Non-Evaluable after the subject had any resections / received prohibited therapy, an additional step can be added here to compare the assessment date with any On-Study Surgery for the subject and then supersede the pre-existing response as "NE" for visits where lesion assessment dates fall after the resection date.

In addition, checks for data issues can also be added here to show Response as "NE". Eg: Target Responses can be evaluated as "NE" if any Lesion diameter is missing at a visit or if counts of Target Lesions at a visit does not match the counts of Target Lesions at Baseline visit.

## 3.3 NON-TARGET RESPONSE:

Non-Target Response is the response seen from all other lesions (determined at Baseline assessment) besides Target Lesions. Lesion size for Non-target lesions may or may not be collected. However, Non-target lesion status (as determined by investigator) is required. Usually at every visit, the Non-target lesion status (NT_STAT) may be marked as ABSENT"," STABLE"," PRESENT","UNEQUIVOCAL PROGRESSION", or "NOT EVALUABLE". Note: NT_STAT represents the status of Non-Target Lesions mapped from EDC (based on RECIST v1.1 terminology) as identified by the Investigator. Below algorithm is derived based on section 4.3.3. Evaluation of non-target lesions from RECIST v1.1 paper (*Eisenhauer E.A. et al*)..

Non-target Response is then computed using the following order:

- If New-Lesions are absent and NT_STAT = "ABSENT" then NTR = CR

- If New-Lesions are absent and NT_STAT = “STABLE” or “PRESENT” then NTR = n-CR/n-PD
- If New-Lesions are absent and NT_STAT = “UNEQUIVOCAL PROGRESSION” then NTR = PD
- If New-Lesions are absent and NT_STAT = “NOT EVALUABLE” then NTR = NE
- If New-Lesions are present and NTR_STAT = “” then NTR = “”

Afterwards, Numerical order (NTR_N) is assigned to each response, such that first (maximum value) number is chosen and converted back to its corroborated response, if different values are present for Non-Target lesions in a visit. Therefore, Maximum NTR_N value is selected for each visit and this value is translated back to its’ original Response for obtaining the Visit Non-Target Response for the subject. (Note: Numbering can also be assigned in reverse order). Again, order of choosing the responses below is important.

- If NTR = “PD” then NTR_N = 4

- If NTR = “NE” then NTR_N = 3

- If NTR = “n-CR/n-PD” then NTR_N = 2

- If NTR = “CR” then NTR_N = 1

- If NTR = “” then NTR_N =. (Missing)

In addition, special conditions (as per protocol) as required for Response evaluation can be added in this step as well, if required (as discussed in section 3.2).

### 3.4 VISIT OVERALL RESPONSE:

After the Target and Non-target responses derived, visit overall responses (OR) are derived in the following order with algorithm derived from table 1 and 2 from RECIST v1.1 paper (*Eisenhauer E.A. et al*):

**Table 1 – Time point response: patients with target (+/– non-target) disease.**

| Target lesions | Non-target lesions | New lesions | Overall response |
|---|---|---|---|
| CR | CR | No | CR |
| CR | Non-CR/non-PD | No | PR |
| CR | Not evaluated | No | PR |
| PR | Non-PD or not all evaluated | No | PR |
| SD | Non-PD or not all evaluated | No | SD |
| Not all evaluated | Non-PD | No | NE |
| PD | Any | Yes or No | PD |
| Any | PD | Yes or No | PD |
| Any | Any | Yes | PD |

CR = complete response, PR = partial response, SD = stable disease, PD = progressive disease, and NE = inevaluable.

**Table 2 – Time point response: patients with non-target disease only.**

| Non-target lesions | New lesions | Overall response |
|---|---|---|
| CR | No | CR |
| Non-CR/non-PD | No | Non-CR/non-PD[a] |
| Not all evaluated | No | NE |
| Unequivocal PD | Yes or No | PD |
| Any | Yes | PD |

CR = complete response, PD = progressive disease, and NE = inevaluable.

a ‘Non-CR/non-PD’ is preferred over ‘stable disease’ for non-target disease since SD is increasingly used as endpoint for assessment of efficacy in some trials so to assign this category when no lesions can be measured is not advised.

Table1 and Table2: Table1 (Eisenhauer, 2009) shows the time point (visit) responses for subjects with both Target and Non-target lesions present, while Table2 (Eisenhauer, 2009) shows the time point response for subjects with only Non-Target lesions.

- If New-Lesions are absent and TR = "CR" and NTR = "CR" then OR = "CR"
- If New-Lesions are absent and TR = "CR" and NTR = "n-CR/n-PD" then OR = "PR"
- If New-Lesions are absent and TR = "CR" and NTR = "NE" then OR = "PR"

- If New-Lesions are absent and TR = "CR" and NTR = "PD" then OR = "PD"

- If New-Lesions are absent and TR = "PR" and NTR = "" then OR = "PR"
- If New-Lesions are absent and TR = "PR" and (NTR = "CR" or NTR = "n-CR/n-PD") then OR = "PR"
- If New-Lesions are absent and TR = "PR" and NTR = "PD" then OR = "PD"
- If New-Lesions are absent and TR = "PR" and NTR = "NE" then OR = "NE"

- If New-Lesions are absent and TR = "SD" and NTR = "PD" then OR = "PD"
- If New-Lesions are absent and TR = "SD" and NTR = "NE" then OR = "NE"
- If New-Lesions are absent and TR = "SD" and (NTR ne "PD" or NTR ne "NE") then OR = "SD"
- If New-Lesions are absent and TR = "SD" and NTR = "NE" then OR = "NE"

- If New-Lesions are absent and TR = "NE" and NTR = "PD" then OR = "PD"
- If New-Lesions are absent and TR = "NE" and NTR ne "PD" then OR = "NE"

- If TR = "PD" or NTR = "" or NL = "Y" then OR = "PD"

Again, a numerical order (OR_N) assigned to each response, such that first number is chosen and converted back to its corroborated response, if present in the group in a visit (Note: Numbering can also be assigned in reverse order).

- If OR = “CR” then OR_N = 5

- If OR = “PR” then OR_N = 4

- If OR = “SD” then OR_N = 3

- If OR = “PD” then OR_N = 2

- If OR = “NE” then OR_N = 1

### 3.5 BEST OVERALL RESPONSE:

Best Overall Response is the best response from all visit overall responses as achieved by subject during the study and algorithm derived from table 3 from RECIST v1.1 paper (*Eisenhauer E.A. et al*). For this, a numerical value assigned with each response (OR_N) in the order of Response and then selecting the Best value in order of this numerical value is the first step. This numerical value later translated to its corresponding response to select Best Overall Response (BOR).

As described above best numerical value from Visit overall response selected as BOR but it can only be done in Randomized trials as per RECIST. However, in non-randomized trials where Response is the primary endpoint, confirmation on Response (CR or PR) is required for it to be Best Overall Response for which additional parameters are checked as below.

**Table 3 – Best overall response when confirmation of CR and PR required.**

| Overall response First time point | Overall response Subsequent time point | BEST overall response |
|---|---|---|
| CR | CR | CR |
| CR | PR | SD, PD or PR[a] |
| CR | SD | SD provided minimum criteria for SD duration met, otherwise, PD |
| CR | PD | SD provided minimum criteria for SD duration met, otherwise, PD |
| CR | NE | SD provided minimum criteria for SD duration met, otherwise NE |
| PR | CR | PR |
| PR | PR | PR |
| PR | SD | SD |
| PR | PD | SD provided minimum criteria for SD duration met, otherwise, PD |
| PR | NE | SD provided minimum criteria for SD duration met, otherwise NE |
| NE | NE | NE |

CR = complete response, PR = partial response, SD = stable disease, PD = progressive disease, and NE = inevaluable.
a If a CR is truly met at first time point, then any disease seen at a subsequent time point, even disease meeting PR criteria relative to baseline, makes the disease PD at that point (since disease must have reappeared after CR). Best response would depend on whether minimum duration for SD was met. However, sometimes 'CR' may be claimed when subsequent scans suggest small lesions were likely still present and in fact the patient had PR, not CR at the first time point. Under these circumstances, the original CR should be changed to PR and the best response is PR.

Table3: Table3 (Eisenhauer, 2009) shows the Best Overall Response for subjects based on their first time point and subsequent time point.

### 3.5.1 If responses require Confirmation

According to RECIST, open label studies require confirmation of Responses if claimed as Best Overall Response. Therefore, it is essential to compare the Current Visit Overall Response with the Previous Visit Overall Response to check for confirmation.

One of the approaches to do this is by creating a new intermediate variable and bringing the previous visit overall response to this record using lag function, so that it reflects the Ex- Visit overall response in the same row for confirmation of responses.

### 3.5.2 If subsequent responses meet minimum duration criteria

Although most studies are designed as, such that the lesion assessment visits should be falling 28 days apart (minimum duration criteria required by RECIST for confirmation of Responses), but still the duration need to be checked in case of certain conditions. For instance, there could be any Unscheduled visits happening during this interval (not meeting the criteria), or maybe any other potential data issues (especially in ongoing studies), therefore one needs to make sure that this condition is also thoroughly checked so as to avoid any potential errors for response confirmation.

For this, a new intermediate variable can be created (like the creation of Ex- Visit overall response), and this Ex- Visit Assessment Dates can be compared to the current visit assessment dates for the duration between the two visits. If this duration equals or exceeds the interval of 28 days and flag is positive for matching responses, a response confirmation flag would be positive, and Response derived deemed as Best Confirmed Response.

### 3.5.3 When Responses are not confirmed and/or Minimum duration is not met

If responses are not matching then based on Minimum duration criteria met (28 days or more) flag – different approach used to derive the Best Unconfirmed Response (algorithm derived from table 3, RECIST paper):

### 3.5.4 Claiming SD as Best Response

If first response (after Baseline assessment) is Positive (CR and PR) and meets minimum duration criteria but does not show any confirmation and becomes non-responder later, SD can be claimed as the Best Response.

For these records, a SD Flag and another variable called SD Response created for these subjects. This separate SD Response can later be compared with Confirmed and unconfirmed responses.

To summarize – for studies requiring confirmation of Responses, we can compute Confirmed, Unconfirmed and SD Responses and then claim BOR as the Best Response by selecting the Best Numerical counterparts of these Responses and then translating it back to the Best Overall Response.

## 4. SPECIAL CONSIDERATIONS:

In case of Ongoing Studies when we might not be having enough Data to analyze the Best Response for a subject – project team might want to show Unconfirmed Responses especially when the data looks promising in terms of Efficacy. However, below scenarios must be confirmed by the study team (clinicians and statisticians) before deciding to interpret as given.

### 4.1 IF SINGLE RESPONSE IS PRESENT

If single response (CR or PR) is present after Baseline for a subject then it can be reflected as Unconfirmed CR or PR, and an asterisk may be used besides them (CR* and PR*) and explained via a footnote.

### 4.2 LATEST RESPONSE IS POSITIVE

If multiple response is present but last visit overall response is CR or PR, it can be decided by the Study team as to if they would like to show the response as unconfirmed and footnote it as mentioned above.

### 4.3 MISSING LESION DATA

Sometimes subsequent visits after Baseline might have missing data for one or more lesions (Target and Non-target). In such cases, SLD might show up as lower than previous visits leading to incorrect response evaluations. To ensure correct evaluation of Response in such cases, a Flag can be derived based on comparing the number of Lesions captured at Baseline and number of Lesions (or missing Lesion size) being captured at each subsequent visit. Using this flag, response can be considered NE (Not evaluable) for visits where count of these lesions (Target and Non-target) do not match the lesions captured at Baseline.

## CONCLUSION

Although the process of deriving responses from Lesion size is somewhat long and a bit complex but with meticulous planning and a good understanding of RECIST principles, it is achievable. In addition, since it involves many steps to reach the Best Overall Response, it is highly recommended that an Independent programming be used for a thorough QC and Validation of these results.

And even though RECIST guidelines are there to assist us in most of the cases but there might be other scenarios or special cases where other team members (clinicians, statisticians) need to identify and take the final decision on interpreting the data and results.

Moreover, splitting or merging lesion data is not described here so if the study involved has such data

present, additional steps would be needed for determining the Lesions SLDs before computing responses.

Also, in certain studies and based on certain statistical or medical considerations, unconfirmed responses may be of significance in which case additional customizations can be done as described in section 4.

## REFERENCES


Bob Zhong, J. L. (2017). SAS Macro for Derivation of Best Overall Response per RECIST 1.1. *PharmaSUG - Paper AD24* (pp. 1-9). PharmaSUG.

Eisenhauer, E. (2009). New response evaluation criteria in solid tumours: Revised RECIST guideline (version 1.1). *EUROPEAN JOURNAL OF CANCER*, 228-247.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## RECOMMENDED READING

- *Base SAS® Procedures Guide*
- *SAS® For Dummies®*
- *New response evaluation criteria in solid tumours: Revised RECIST guideline*

## CONTACT INFORMATION

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