RECORDS:
Improved Reporting of MontE CarlO RaDiation Transport Studies

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INTRODUCTION

- Monte Carlo (MC)-based computer simulations are common in diagnostic and therapy medical physics
- Variation in design and execution of MC simulations can result in large variations in the final results
- Judging the appropriateness of MC implementation and parameters in a peer-reviewed article is important, but increasingly challenging
- Many manuscripts give a paucity of detail regarding both the setup and the results of their MC simulations

AIM

- To develop guidelines to improve reporting of Monte Carlo studies in medical physics research
- To increase the level of relevant detail of descriptions used in these studies to increase:
  - the level of transparency
  - the ability to reproduce results
  - the overall scientific value of these studies

METHODS

- AAPM Task Group #268 developed a checklist of the items that should be included in the Methods, Results and Discussion sections of manuscripts that include Monte Carlo simulation as a substantial aspect of the work
- An optional template table is also proposed for the Methods section to include many of the checklist items that are possible to describe with short phrases and/or references to previous work

CHECKLIST OF ITEMS TO INCLUDE IN A MONTE CARLO PUBLICATION

Section & Topic	No	Item
TITLE		
	1	Identification as a Monte Carlo study.
METHODS		
Software	2*	Name of Monte Carlo software used, including a reference to a paper and/or report describing the package, if available.
	3*	Release number and/or release date of Monte Carlo software used.
	4a*	Description of validation of used code in similar or at least relevant applications, preferably via references.
	4b*	If code is being validated against experimental measurements, then detailed description of experimental conditions and of simulation. For the latter, inclusion of assumptions and simplifications of the experimental conditions.
Geometry	5	Description of simulation geometry, using drawings and tables as needed. Provide all relevant dimensions which are not proprietary. If possible, provide equivalent composition and dimension information in place of proprietary details.
	6	Description of material composition and mass density of each item in the geometry, with references if applicable. Provide the elemental composition and/or, if applicable, the Hounsfield Units conversion method.
Source	7*	Description of the source, including source of phase-space files if used, providing parameters (type, energy and its distribution including bin size, direction, distribution and modulation, etc.). Provide reference, if applicable.
Physics and Transport	8*	Specification of the relevant cross section data used.
	9*	Specification of transport parameters used, such as cutoffs, step sizes and thresholds. Also transport algorithms if there is more than one option for the code used. Specifying use of the default is adequate if it is unique.
	10*	Specification of variance reduction (VRT) and approximate efficiency improvement techniques (AEIT) used, and their parameters. References describing them or specific descriptions of any new techniques must be included if they are not included in the MC software as built-in options.
Scoring	11*	Specification of all scored quantities. Provide tally names if using a standard Monte Carlo software that includes them, but also include what physical quantity is scored by the tally. When results are binned, tabulated values must make clear what the variable means, e.g., the mid-point, top or range of a bin.
	12*	Number of histories and number of source particles used. If simulations involved different numbers of histories and source particles, provide range.
	13*	Description and reference for method to estimate statistical uncertainty, including if estimated by the history-by-history or the batch method.
Analysis	14*	Description of how scored quantities are normalized and/or converted to other metrics. List physical conversion factors used and provide references, if applicable, if there are multiple values for these in the literature.
	15*	Description of how scored quantities are de-noised or otherwise filtered, with references, if applicable. If none, then this should be specifically mentioned.
RESULTS		
	16*	Results of validation.
	17*	Scored quantities with statistical uncertainty including a specification of the confidence limits used. In general, graphical representation of results such as depth-dose curves or spectra should be histogram rather than point plots, and include uncertainty estimates with error bars in the graphs or text in the caption.
	18a*	If study is related to Monte Carlo efficiency, specification of CPU/GPU time, compiler information, and system used to perform the simulations, including CPU/GPU model number.
	18b*	Otherwise specification of order of magnitude of CPU/GPU time and CPU/GPU model number.
DISCUSSION		
	19	Discussion of study limitations, including sources of potential bias, statistical uncertainty, and generalizability.
	20	Discussion of assumptions and approximations and their potential effect on the results, given the knowledge gained.

OPTIONAL METHODS TABLE

Check list Item #	Item Name	Description	Ref.
2, 3	Code, version/ release date		
4, 16	Validation		
7	Source description		
8	Cross sections		
9	Transport parameters		
10	VRT and/or AEIT		
11	Scored quantities		
12, 17	# histories/ statistical uncertainty		
13	Statistical methods		
14, 15	Post-processing		
18	Timing		

DISCUSSION

- It is envisioned that this list will be useful both for authors and for reviewers
- The omission of any of the items listed in the checklist should not be automatically taken as disqualifying
- There might be cases in which some items are either not applicable, irrelevant, or have no significant impact on the study

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Full report can be downloaded at:
https://www.aapm.org/pubs/reports/detail.asp?docid=168