PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Using a retrospective cross-sectional study to analyse unintentional fatal drowning in Australia: ICD-10 coding based methodologies verses actual deaths
AUTHORS	Peden, Amy; Franklin, Richard; Mahony, Alison; Scarr, Justin; Barnsley, Paul

VERSION 1 – REVIEW

REVIEWER	Dr Stephen B Beerman University of British Columbia Canada
REVIEW RETURNED	10-Sep-2017

GENERAL COMMENTS	Great work and thank you for the detailed analysis of data that is important to illumination and resource/focus assignments for prevention effort in Australia and globally The reviewer also provided a marked copy with additional comments. Please contact the publisher for full details.

REVIEWER	Ulf Martin Schilling Dept of Clinical education and simulation and unit for innovation, testing and technology assessment University hospital of Linköping Sweden
REVIEW RETURNED	16-Sep-2017

GENERAL COMMENTS	Thank you for a well written manuscript. The manuscript highlightens a potential problem related to the ICD10 coding and its use for the description of the primary and related causes of death in drowning. You found a significant discrepancy between the coded causes of death by the ICD10 and by the database of the Royal Life Saving Society. In your limitations as well as in the text I cannot find any reference towards the quality of this database, giving the impression that the database would be the golden standard you measure the ICD system against. Whilst this might be correct or not, it would need clarification for the reader. THe only reference to the database quality is found on page 13 first line "the database currently includes unintentional drowning only". This means that you cross referenced two databases against each other, both with limitations and seemingly incomplete data.Whilst you correctly conclude that it might be easier to examine all drowning cases (p13 line 2-3), you neither offer a solution to this issue nor mention it in the limitations of the study. Which solution would you suggest to solve this issue?

	As you describe a major disparity between the ICD and the presumptive cause of death in drowning related to accidents and disasters, you state that "water related transport poses a challenge for identifying drowning deaths" as "only 20% pf watercraft related drowning incidents had a code of W65-74" (p11 line 29-30) and cite Finland, Philippines and Uganda. You state that "this has implications for countries with a large number of water transportation-realted drowning deaths" (p11 line 35-36). Which implications? As 50% of drowning in Finland is related to the combination of boats and alcohol with single drowning victims (mostly male), whilst drowning in the Philippines is affected by disastrous ship-accidents with hundreds of victims, what is the resulting implication you mention?
	Essentially, you highlight the problem with the actual system and use of the ICD10 coding (and indirectly, with the database of the Royal life saving society), and the limitations with the use of W 65-74 codings only. In my opinion, it would strengthen your discussion (and your manuscript) if you could suggest some of the resulting implications you mention and offer possible solutions. In the current version, this part falls a little short as the reader is left alone with the figures presented and open endings such as "this has implications..." (p13 line 20-21 and line 35-36).
	Page 13 line 49 you find the underrepresentation of non-aquatic drowning related deaths, directly followed by the different prevention strategy. I understand the logical connection but would suggest to try to smooth the rather brusque formulation somehow as the connection might not be evident for all readers. Essentially you say "we found an underrepresentation in the statistics. prevention methods are different". Would it be possible to rephrase this for the non-expert reader?
	So in conclusion - you provided a well written relatively solid manuscript. It might be wise to more thoroughly consider the limitations of both databases, "smooth" some formulations in the discussion part, and be more concise regarding the implications of your results in the parts mentioned above.

| REVIEWER | Jonathon Webber
The University of Auckland,
New Zealand. |
| REVIEW RETURNED | 17-Sep-2017 |

| GENERAL COMMENTS | Well written paper that clearly highlights the issues around classification of drowning incidents in highly reliable HIC state/federal system, but which also addresses the issue of 'individuality' when practitioners assign (or do not assign) an ICD code.

This paper has a clear, logical order and flow, and the style of writing is in plain English.
The tables and figure and well ordered and relevant.
One aspect of the discussion/conclusion is that this piece of work could also provide the impetus for other countries to conduct a similar review of their system, thereby improving the quality of data collection worldwide. This could make international comparability of data easier, and also assist in improving WHO definitions/coding, and the accuracy of the figure assigned by the WHO to quantify the global burden of drowning. |

REVIEWER	Dr. Aminur Rahman
	Centre for Injury Prevention and Research, Bangladesh (CIPRB); Bangladesh
REVIEW RETURNED	19-Sep-2017

GENERAL COMMENTS	The paper is very well written. It will provide a wealth of knowledge to the researchers working in this area and also be useful to rethink about the ICD-10 coding particularly events like drowning.

REVIEWER	Sarah Stempski
	Seattle Children's Hospital
	United States
REVIEW RETURNED	25-Sep-2017

GENERAL COMMENTS	This work is important to accurately estimating the burden of injury from unintentional fatal drowning. The authors clearly outline their methodology for collecting cases that were not captured in UCoD only codes and discuss the impact within segments of the population (global impact, water-related transport, etc).
	Specific areas for consideration:
	Page 8, line 35: With the proportion of drowning cases missing having decreased over time, perhaps that would warrant some further discussion of this in the discussion section on how this affects future estimates of drowning burden.
	Page 10, line 52: Consider using this introductory summary to clarify your abstract and conclusion.
	Page 14, line 12: "This study found a 39% difference..." suggest changing to "This study found 61% of unintentional drowning deaths were captured when primary drowning codes were used, a 39% difference from..." and explain what the 39% difference is from. This will better align with the next figure of increasing to 92% when multiple cause of drowning codes were allowed.
	Page 14, line 13: "Where multiple cases of drowning deaths are allowed..." Suggest changing "Where" to "When" to clarify the sentence.

REVIEWER	Tessa Clemens
	The Hospital for Sick Children, Canada
REVIEW RETURNED	28-Sep-2017

GENERAL COMMENTS	This is a well written paper with important implications for our understanding of the true burden of fatal drowning as well as for drowning prevention.
	In the Methods section (page 6, line 45) please clarify "Cases with an open coronial finding as to the victim's intent". Does open here have the same definition as indicated in line 50 "(still under investigation)". Or does "open" here refer to closed cases where the intent was undetermined?
	On page 10 line 3 consider changing to "intentional self-harm (X71)" for clarity.

	Consider including X92 in Table 1 with (N) = 0 since all other drowning and drowning related codes are included (including X71), yet exclusion of both suicide and homicide related drowning is indicated in methods, and 19 X71 cases were still found.
	Page 12 line 15-25, consider re-wording/re-organizing sentence to be less cumbersome.
	Consider providing further detail in limitations section on page 13 of the report with regards to 'variation due to time taken to close coronial cases and reporting of official cause of death statistics may impact data quality' as indicated on page 3.
	Page 14, line 12, re-word first sentence of conclusion.

VERSION 1 – AUTHOR RESPONSE

REVIEWER #1 - DR STEPHEN B BEERMAN
SUGGESTED REVISION: Great work and thank you for the detailed analysis of data that is important to illumination and resource/focus assignments for prevention effort in Australia and globally
AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: I have embedded comment within the attached PDF file - I hope these are helpful.

AUTHOR COMMENT: Thank you for these comments. We have made the editorial changes recommended in the marked up PDF. With respect to the suggestion regarding including intentional deaths coded X92 and X71, there were no deaths coded as X92 in the Royal Life Saving National Fatal Drowning Database (the Database). The X71s were included as they were deemed to be unintentional based on the information available at the time of collating the Database and upon re-examination, the vast majority were unintentional and coded X71 in error. Therefore the authors of this study would prefer to maintain the current scope of the study as proposed, however we have added the fact that there were no cases coded assault by drowning and submersion (X92) in the results and in Table 1.

With respect to your point about the ICD codes used in the WHO Global Report on Drowning, page 50 of the report (Appendix 2), notes that the global estimate of 372,441 is derived from "ICD-10 categories W65-W74, and therefore do not include drownings due to natural disasters, intentional drownings, or aquatic transport."

REVIEWER #2 - ULF MARTIN SCHILLING
SUGGESTED REVISION: Thank you for a well written manuscript. The manuscript highlightens a potential problem related to the ICD10 coding and its use for the description of the primary and related causes of death in drowning. You found a significant discrepancy between the coded causes of death by the ICD10 and by the database of the Royal Life Saving Society. In your limitations as well as in the text I cannot find any reference towards the quality of this database, giving the impression that the database would be the golden standard you measure the ICD system against. Whilst this might be correct or not, it would need clarification for the reader.

The only reference to the database quality is found on page 13 first line "the database currently includes unintentional drowning only". This means that you cross referenced two databases against each other, both with limitations and seemingly incomplete data. Whilst you correctly conclude that it might be easier to examine all drowning cases (p13 line 2-3), you neither offer a solution to this issue nor mention it in the limitations of the study. Which solution would you suggest to solve this issue?

AUTHOR COMMENT: Thank you for this comment. This study didn't compare two databases, it examined the use of ICD codes within the Royal Life Saving National Fatal Drowning Database, which primarily drew case information from the National Coronial Information System (NCIS). The Database also uses multiple sources (such as media, police and child death review reports) to find and code cases (with a heavy reliance on the NCIS), but we believe that this provides it with a level of comprehensiveness that no other drowning dataset is able to match.

We have added the following to the limitations section to clarify the methodology and any issues associated with this: "This study uses the Database of an Australian drowning prevention advocacy organisation, drawn from an online coronial database, as well as a range of other reports (for example police, media and child death review) that need to be corroborated by multiple sources. It is still possible there may be missing data (for example bodies missing at sea with no associated report).

With respect to the issue of comparing both intentional and unintentional drowning deaths, this database includes unintentional drowning deaths only. Through the process of collating the Database, a small number of cases coded X71 (intentional self-harm) were included due to the case still being open (under investigation by the coroner) at the time of collation. Ultimately the solution is to include both intentional and unintentional, however the prevention strategies are likely to differ and limited resources make this a challenge. The focus of the Royal Life Saving Society – Australia to date has been the prevention of unintentional drowning, and therefore that is the focus of the database at this point.

SUGGESTED REVISION: As you describe a major disparity between the ICD and the presumptive cause of death in drowning related to accidents and disasters, you state that "water related transport poses a challenge for identifying drowning deaths" as "only 20% pf watercraft related drowning incidents had a code of W65-74" (p11 line 29-30) and cite Finland, Philippines and Uganda. You state that "this has implications for countries with a large number of water transportation-realted drowning deaths" (p11 line 35-36). Which implications? As 50% of drowning in Finland is related to the combination of boats and alcohol with single drowning victims (mostly male), whilst drowning in the Philippines is affected by disastrous ship-accidents with hundreds of victims, what is the resulting implication you mention?

AUTHOR COMMENT: Thank you for this comment, the implications you mentioned are around the impact of water transportation related drowning being coded to other 'non-drowning' ICD codes and the implication this has for the country and global estimates of drowning which in turn has implications for resource allocation for prevention. We have clarified this section of the manuscript as follows: "This has implications for estimates of fatal drowning and therefore resource allocation for prevention in countries with a large number of water transportation-related drowning deaths such as Finland (20), Philippines (42) and Uganda (43)."

SUGGESTED REVISION: Essentially, you highlight the problem with the actual system and use of the ICD10 coding (and indirectly, with the database of the Royal life saving society), and the limitations with the use of W 65-74 codings only. In my opinion, it would strengthen your discussion (and your manuscript) if you could suggest some of the resulting implications you mention and offer possible solutions. In the current version, this part falls a little short as the reader is left alone with the figures presented and open endings such as "this has implications..."(p13 line 20-21 and line 35-36).

AUTHOR COMMENT: Thank you for this comment, we have further clarified the implications on page 13 line 20-21 as follows:

"This has implications for resource allocation to drowning prevention due to the impacts of undercounting on community, national and global estimates (2)."

We have also further clarified what the implications are on page 13, line 35-36 as follows:

"This has implications for estimates of fatal drowning and therefore resource allocation for prevention in countries with a large number of water transportation-related drowning deaths such as Finland (20), Philippines (42) and Uganda (43)."

With respect to proposing solutions, the real solution would be providing multiple cause of death codes, so as much information as possible can be used about the death to guide prevention. We have added the following discussion point to the end of the global implications section to cover off this point. "This has implications for resource allocation to drowning prevention due to the impacts of undercounting on community, national and global estimates (2). We would encourage all countries to have multiple causes of death provided, thus allowing for a greater understanding of the impact of drowning and the development of multi-faceted prevention strategies. All nations should be made aware of the challenges associated with, and prioritise, the collection and utilisation of drowning data."

SUGGESTED REVISION: Page 13 line 49 you find the underrepresentation of non-aquatic drowning related deaths, directly followed by the different prevention strategy. I understand the logical connection but would suggest to try to smooth the rather brusque formulation somehow as the connection might not be evident for all readers. Essentially you say "we found an underrepresentation in the statistics. prevention methods are different" . Would it be possible to rephrase this for the non-expert reader?

AUTHOR COMMENT: Thank you for this comment, we agree and have rephrased to make the transition from data issue into prevention more clear. The rephrased section is as follows:

"Non-aquatic transport incidents are recorded with a UCOD of W65-74 in 13% of incidents, this underrepresentation has also been observed in New Zealand (17). The challenge of such incidents is that traditional drowning prevention stratagems may not be effective as taking a road traffic-related approach. We posit that risk mitigation strategies for these drowning deaths may include early warning systems, flood depth markers, warning signage, bridges and culverts (44)."

SUGGESTED REVISION: So in conclusion - you provided a well written relatively solid manuscript. It might be wise to more thoroughly consider the limitations of both databases, "smooth" some formulations in the discussion part, and be more concise regarding the implications of your results in the parts mentioned above.

AUTHOR COMMENT: Thank you for this comment, we have actioned the suggestions made by the reviewer above. No further action required.

REVIEWER #3 - JONATHON WEBBER

SUGGESTED REVISION: Well written paper that clearly highlights the issues around classification of drowning incidents in highly reliable HIC state/federal system, but which also addresses the issue of 'individuality' when practitioners assign (or do not assign) an ICD code.

AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: This paper has a clear, logical order and flow, and the style of writing is in plain English.

AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: The tables and figure and well ordered and relevant.

AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: One aspect of the discussion/conclusion is that this piece of work could also provide the impetus for other countries to conduct a similar review of their system, thereby improving the quality of data collection worldwide. This could make international comparability of data easier, and also assist in improving WHO definitions/coding, and the accuracy of the figure assigned by the WHO to quantify the global burden of drowning.

AUTHOR COMMENT: Thank you for this suggestion, we agree. We have added the following to the first paragraph in the prevention section of the discussion as follows:
"An accurate count of the number of people who drown (both fatal and non-fatal) is important for prevention. The approach used can impact drowning mortality numbers as well as the profile. The proportion of cases without ICD coding decreased across the study period, which has implications for drowning statistics in Australia. Future research should examine if similar trends are occurring in other countries. This study may also provide the impetus for other countries to conduct similar reviews of their own systems, thereby improving the quality and comparability of drowning data collected worldwide, as well as assist in improving WHO definitions, coding and global estimates."

REVIEWER #4 - DR AMINUR RAHMAN
SUGGESTED REVISION: The paper is very well written. It will provide a wealth of knowledge to the researchers working in this area and also be useful to rethink about the ICD-10 coding particularly events like drowning.

AUTHOR COMMENT: Thank you for this comment, no action required.

REVIEWER #5 - SARAH STEMPSKI
SUGGESTED REVISION: This work is important to accurately estimating the burden of injury from unintentional fatal drowning. The authors clearly outline their methodology for collecting cases that were not captured in UCoD only codes and discuss the impact within segments of the population (global impact, water-related transport, etc).

AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: Specific areas for consideration:
Page 8, line 35: With the proportion of drowning cases missing having decreased over time, perhaps that would warrant some further discussion of this in the discussion section on how this affects future estimates of drowning burden.

AUTHOR COMMENT: Thank you for this comment, we have added the following information in the first paragraph of the prevention section of the discussion to address this issue: "The proportion of cases without ICD coding decreased across the study period, which has implications for drowning statistics in Australia. Future research should examine if similar trends are occurring in other countries."

SUGGESTED REVISION: Page 10, line 52: Consider using this introductory summary to clarify your abstract and conclusion.

AUTHOR COMMENT: Thank you for this comment, we have used the introductory section of the discussion to revise the abstract and conclusion as follows:

Abstract – revised the results and conclusion section as follows:

"Results: The Database recorded 1,428 drowning deaths. 866 (60.6%) had an UCoD of W65-74 (accidental drowning), 249 (17.2%) cases had an UCoD of either T75.1 (0.2%), V90 (5.5%), V92 (3.5%), X38 (2.4%) or Y21 (5.9%) and 53 (3.7%) lacked ICD coding. Children (0-17 years) were closely aligned (73.9%), however watercraft (29.2%) and non-aquatic transport (13.0%) were not. When the UCoD and all subsequent causes are used 67.2% of cases include W65-74 codes. 91.6% of all cases had a drowning code (T75.1, V90, V92, W65-74, X38 and Y21) at any level.

Conclusions: Defining drowning with the codes W65-74 and using only the UCoD captures 61% of all drowning deaths in Australia. This is unevenly distributed with adults, watercraft and non-aquatic transport-related drowning deaths underrepresented. Using a wider inclusion of ICD codes, which are drowning-related and multiple causes of death minimises this underrepresentation. A narrow approach to counting drowning deaths will negatively impact the design of policy, advocacy and program planning for prevention."

Conclusion

"Inclusion and exclusion in drowning mortality data collection and reporting produces substantial discrepancies that influence the illumination of the burden and resource allocation for prevention. This study found 61% of unintentional drowning deaths are captured based on a single level, narrow drowning definition (W65-74). When multiple cause codes were allowed, and an expanded number of ICD codes (T75.1, V90, V92, W65-74, X38 and Y21), this figure increased to 92%. Reporting of watercraft and non-aquatic transport-related drowning deaths is an ongoing challenge within the current ICD-10 external cause classification system. This has implications for the design of policy, advocacy and program planning for drowning prevention."

SUGGESTED REVISION: Page 14, line 12: "This study found a 39% difference..." suggest changing to "This study found 61% of unintentional drowning deaths were captured when primary drowning codes were used, a 39% difference from..." and explain what the 39% difference is from. This will better align with the next figure of increasing to 92% when multiple cause of drowning codes were allowed.

AUTHOR COMMENT: Thank you for this comment, we have rephrased the conclusion of the manuscript as follows:

"Inclusion and exclusion in drowning mortality data collection and reporting produces substantial discrepancies that influence the illumination of the burden and resource allocation for prevention. This study found 61% of unintentional drowning deaths were captured when primary drowning codes were used (W65-74) as the UCoD only. Those cases not captured were commonly fatal drowning as a result of watercraft or non-aquatic transport incidents. When multiple cause codes were allowed, and an expanded number of ICD codes (T75.1, V90, V92, W65-74, X38 and Y21), this figure increased to 92%. Reporting of watercraft and non-aquatic transport-related drowning deaths is an ongoing challenge within the current ICD-10 external cause classification system. This has implications for the design of policy, advocacy and program planning for drowning prevention."

SUGGESTED REVISION: Page 14, line 13: "Where multiple cases of drowning deaths are allowed..." Suggest changing "Where" to "When" to clarify the sentence.

AUTHOR COMMENT: Thank you for this comment, we have made this change as suggested. This sentence now reads as follows: "When multiple cause of drowning codes were allowed, and an expanded number of ICD codes, this figure increased to 92%."

REVIEWER #6 - TESSA CLEMENS

SUGGESTED REVISION: This is a well written paper with important implications for our understanding of the true burden of fatal drowning as well as for drowning prevention.

AUTHOR COMMENT: Thank you for this comment, no action required.

SUGGESTED REVISION: In the Methods section (page 6, line 45) please clarify "Cases with an open coronial finding as to the victim's intent". Does open here have the same definition as indicated in line 50 "(still under investigation)". Or does "open" here refer to closed cases where the intent was undetermined?

AUTHOR COMMENT: Thank you for this comment, you are correct, in this context an open finding means intent was undetermined. We have clarified the wording of this sentence as follows: "Cases with a coronial finding of undetermined as to the victim's intent were included."

SUGGESTED REVISION: On page 10 line 3 consider changing to "intentional self-harm (X71)" for clarity.

AUTHOR COMMENT: Thank you for this suggestion, we have reworded as follows: "There were 19 cases (1.3%) coded as intentional self-harm (X71) of which, on review, three were intentional."

SUGGESTED REVISION: Consider including X92 in Table 1 with (N) = 0 since all other drowning and drowning related codes are included (including X71), yet exclusion of both suicide and homicide related drowning is indicated in methods, and 19 X71 cases were still found.

AUTHOR COMMENT: Thank you for this comment, this was also suggested by another reviewer. We have added a line to the 'Where ICD coding was present' section of the results and also to Table 1 identifying that there were no cases coded as assault by drowning and submersion (X92).

SUGGESTED REVISION: Page 12 line 15-25, consider re-wording/re-organizing sentence to be less cumbersome.

AUTHOR COMMENT: Thank you for this comment, we have split this long sentence into two sentences as follows: "It is also an issue likely to affect isolated areas within a country (such as rural and remote locations), locations and activities where people are more likely to be recreating around water alone and countries that experience natural disasters due to flooding and storm surges. Countries that experience mass drowning events such as those due to large scale water transportation accidents are also likely to be affected by the use of R99."

SUGGESTED REVISION: Consider providing further detail in limitations section on page 13 of the report with regards to 'variation due to time taken to close coronial cases and reporting of official cause of death statistics may impact data quality' as indicated on page 3.

AUTHOR COMMENT: Thank you for this suggestion, we have added the suggested text to the limitations and this section now reads as follows: "This information represents Australia only and as such, further work in other countries is required. There was variation in missing ICD codes across Australia (range 0.0% in the Australian Capital Territory and Western Australia to 6.7% in Queensland). Variation due to the time taken to close coronial cases and the reporting of official cause of death statistics may also impact data quality. The information is correct as of 31 December 2016. Coronial data is subject to change until closed (5.8% open cases). "

SUGGESTED REVISION: Page 14, line 12, re-word first sentence of conclusion.

xAUTHOR COMMENT: Thank you, we have reworded the first sentence of the conclusion as follows: "Inclusion and exclusion in drowning mortality data collection and reporting produces substantial discrepancies that influence the illumination of the burden and resource allocation for prevention."

VERSION 2 – REVIEW

REVIEWER	Dr Stephen Beerman Dept of Family Medicine Faculty of Medicine University of British Columbia Canada Drowning Prevention
REVIEW RETURNED	15-Oct-2017

GENERAL COMMENTS	Thank you for this work that well designed and well done

REVIEWER	Martin Schilling Dept of clinical education and simulation Clinicum East Sweden University hospital of Linköping Region of Östergötland Sweden
REVIEW RETURNED	24-Oct-2017

GENERAL COMMENTS	Thank you very much for the revised manuscript. In this version, I feel the questions raised by the earlier manuscript to be adressed appropriately.There is a high percentage of self-references, however, considering the topic and the context of the manuscript this seems unavoidable.

REVIEWER	Sarah Stempski Seattle Children's Hospital, United States
REVIEW RETURNED	26-Oct-2017

GENERAL COMMENTS	Revisions addressed my previous suggestions for edits.

REVIEWER	Tessa Clemens Centre for Global Child Health, The Hospital for Sick Children, Canada
REVIEW RETURNED	25-Oct-2017

GENERAL COMMENTS	Comments/suggestions were adequately addressed. I recommend accepting this version of the manuscript.