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Anti-Mullerian hormone (AMH) test information on Australian and New Zealand fertility clinic websites: A content analysis

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3 **Anti-Mullerian hormone (AMH) test information on Australian and New Zealand fertility clinic**
4 **websites: A content analysis**
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8 Tessa Copp*^{1,2}, Brooke Nickel^{1,2}, Sarah Lensen³, Karin Hammarberg^{4,5}, Devora Lieberman⁶, Jenny
9 Doust⁷, Ben W. Mol⁸, Kirsten J. McCaffery^{1,2}
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11

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- 14
- 15 1. Wiser Healthcare, Sydney School of Public Health, Faculty of Medicine and Health, The
16 University of Sydney, 2006, Australia
- 17 2. Sydney Health Literacy Lab, Sydney School of Public Health, Faculty of Medicine and Health,
18 The University of Sydney, 2006, Australia
- 19 3. Obstetrics and Gynaecology, University of Melbourne, Melbourne, Australia, 3052
- 20 4. Victorian Assisted Reproductive Treatment Authority, 3000, Melbourne, Australia
- 21 5. School of Public Health and Preventive Medicine, Monash University, 3004, Melbourne,
22 Australia
- 23 6. City Fertility Centre, Sydney, Australia
- 24 7. Centre of Longitudinal and Life Course Research, School of Public Health, The University of
25 Queensland, Herston, 4006, Australia
- 26 8. Department of Obstetrics and Gynaecology, Monash University, Clayton, 3800, Australia
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34 *Corresponding author: Tessa Copp, Tessa.copp@sydney.edu.au
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Abstract

Objectives: The Anti-Mullerian hormone (AMH) test has been promoted as a way to inform women about their future fertility. However, data consistently shows the test is a poor predictor of natural fertility potential for an individual woman. As fertility centre websites are often a primary source of information for reproductive information, it is essential the information provided is accurate and reflects the available evidence. We aimed to systematically record and categorise information about the AMH test found on Australian and New Zealand fertility clinic websites.

Design: Content analysis of written information about the AMH test.

Setting: Accredited Australian and New Zealand fertility clinic websites

Methods: Data were extracted between April and June 2020. Any webpage that mentioned the AMH test, including blogs specifically about the AMH test posted since 2015, were analysed and the content categorised.

Results: Of the 39 active accredited fertility clinics' websites, 25 included information about the AMH test. The amount of information varied widely, and embodied four overarching categories; 1) the utility of the AMH test, 2) who the test is suitable for, 3) possible actions in response to the test, and 4) caveats and limitations of the test. Eight specific statements about the utility of the test were identified, many of which are not evidence-based. Whilst some websites were transparent regarding the test's limitations, others mentioned no caveats or included persuasive statements actively promoting the test as empowering for a range of women in different circumstances.

Conclusions: Several websites had statements about the utility of the AMH test that are not supported by the evidence. This highlights the need for higher standards for information provided on fertility clinic websites to prevent women being misled to believe the test can reliably predict their fertility.

Strengths and limitations of this study:

- First study to robustly and systematically assess publicly available AMH test information on fertility clinic websites
- Two researchers independently assessed all the extracted information about the AMH test, with any inconsistencies resolved with an additional member of the study team
- Only written content was assessed (e.g. videos were excluded), potentially missing relevant information on the AMH test
- Website content can change over time, meaning that different information may be identified if the study is repeated

INTRODUCTION

A woman's fertility declines with age, due to the reduction in the quality and quantity of her eggs over time.¹ In women, the anti-Mullerian hormone (AMH) is exclusively produced by granulosa cells of ovarian follicles during the early stages of their development.² AMH levels can be measured by a blood test, giving an indication of ovarian reserve, or the number of eggs remaining in the ovaries. In theory, higher levels of AMH indicate the presence of more eggs and higher fertility potential and low levels indicate that there are few eggs left and the woman is approaching menopause. Menopause typically occurs at approximately 50 years of age.³ However, loss of ovarian reserve is accelerated in approximately 10% of women leading to premature menopause and loss of fertility potential before the age of 40 years.⁴ The AMH test has been promoted as a way for women to find out how much longer they have to achieve pregnancy or how likely it is that pregnancy could be achieved at all,⁵ potentially encouraging proactive family planning and preventing childlessness caused by age-related infertility.⁶ Public interest in AMH testing is also increasing with the rise of elective egg freezing in women concerned about age-related fertility decline.^{7,8}

Whilst the AMH test may be valuable in assisted reproductive technology (ART) treatment management through indicating likely ovarian response and enabling personalised dose selection in stimulation protocols,^{9,10} it has limited predictability of live birth rates in both ART^{11,12} and spontaneous conception settings.¹³⁻¹⁵ In addition, whilst a low AMH level may reflect a quantitative decline in ovarian reserve, there is currently no consensus on the level which defines a depleted ovarian reserve. Indeed, pregnancy can still occur even at undetectable AMH levels, especially in young women.^{2,6,16} The AMH test is therefore not a reliable measure of fertility potential.¹³ It can also give false readings for women with polycystic ovary syndrome (PCOS) or who use oral contraceptives.¹⁷ The American College of Obstetricians and Gynaecologists recently released a statement against the use of AMH in women without a diagnosis of infertility as it is not supported by the evidence.¹⁸ Despite this, some fertility specialists and researchers¹⁹ have suggested that women in their late 20s have the test at regular intervals to monitor their fertility potential. In addition, online companies in countries such as the United States, Australia and the United Kingdom are now selling the test direct-to-consumers outside of clinical settings,⁷ offering women estimates of their fertility potential based on the results of the test.

Fertility clinic websites along with social media are primary sources for women seeking reproductive information,²⁰ such as egg freezing.²¹ When "AMH test" or "egg timer test" are entered into the Google search engine, fertility clinic websites are among the first websites to appear. In Australia and New Zealand, fertility clinics must be accredited by the Reproductive Technology Accreditation Committee (RTAC).²² The RTAC Code of Practice states that clinics "...must provide patients with information that is accurate, timely, in formats and language appropriate to the patient...".²² Considering the popular narrative that the AMH test can predict fertility, the aim of this study was to systematically record and categorise information about the AMH test found on Australian and New Zealand fertility clinic websites.

METHOD

Setting

The websites of all accredited fertility clinics in Australia and New Zealand were accessed between April and June, 2020. All webpages that mentioned the AMH test, including posts or blogs

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3 specifically about the AMH test which had been posted since 2015 were scrutinised. Analysis was
4 restricted to written context (i.e. videos and non-text data were excluded). Any webpages described
5 as being specifically for clinicians (e.g. GPs) were also excluded.
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8 **Study design**

9 A content analysis of the information on fertility clinic websites about the AMH test was conducted.
10 Content analysis is a widely used analysis method which combines qualitative and quantitative
11 methods to analyse text data, allowing the content and frequency of categories to be reported.²³
12 Given the uncertain evidence about the utility of the AMH test, we aimed to systematically identify
13 and categorise the statements made about the utility of the AMH test and related information. This
14 method has previously been used to assess claims made on fertility clinic websites about the
15 effectiveness of different treatments.²⁰ The study team included public health researchers (TC, BN,
16 SL, KH, KM), a general practitioner and clinical epidemiologist (JD), a registered nurse (KH) and
17 fertility specialists (BM, DL).
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22 **Patient and public involvement**

23 No patients or public were involved. The data were derived from publicly available information on
24 Australian and New Zealand fertility clinic websites.
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27 **Analysis**

28 The analysis involved an iterative process with five members of the study team. After the data were
29 extracted from the fertility clinic websites by one researcher (TC), content analysis was used to map
30 out the areas of content that emerged and record and categorise the statements made about the
31 AMH test. First, two researchers (TC and BN) independently reviewed information about the AMH
32 test on 20 websites each to become familiar with the content and develop a list of recurring codes
33 and themes. These codes and themes were discussed with a third researcher (SL) and informed an
34 initial coding framework. All content was then coded independently by two researchers (TC and SL)
35 into the framework to ensure rigour. Further revisions to the framework were discussed and made
36 as required during coding. The level of agreement between the two coders was tested using Cohen's
37 kappa and indicated a strong level of agreement ($\kappa=0.83$). Any inconsistencies in coding were then
38 discussed and resolved, with a third researcher (BN) involved to come to a final agreement.
39 Descriptive statistical analysis was used to calculate the frequency of each code, and quotes were
40 chosen to illustrate findings.
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47 **RESULTS**

48 Of the 41 accredited fertility clinics listed on the Fertility Society of Australia's website, two had
49 merged with other fertility clinics, resulting in 39 eligible clinic websites. The number of web pages
50 with content relating to the AMH test varied widely across websites from zero up to 12 pages
51 (mean: 3.4 webpages per clinic website). Of the 39 included websites, 14 (36%) did not mention the
52 AMH test at all and 8 (21%) only listed the test or gave a very brief description of the test, which did
53 not include any additional information such as potential benefits or limitations. The 14 websites that
54 did not mention the AMH test were excluded from the analysis.
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57 Information about the AMH test on the remaining 25 clinic websites was organised into four
58 overarching categories; statements about 1) the utility of the AMH test, 2) who the test is suitable
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3 for, 3) possible actions in response to the test, and 4) statements reflecting caveats and limitations
4 of the test. The overarching categories and their affiliated statements, quotes illustrating each
5 statement and proportions of clinic websites containing each statement are shown in Table 1. In
6 addition, two patterns of observations arose when analysing the data. These included the use of
7 persuasive language and contradictory information within and across websites.
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Table 1. Statements about the AMH test on fertility clinic websites (N=25 websites)

Categories and codes	Example quote	n (%)
Statements about the utility of the AMH test		
Indicator of ovarian reserve/number of eggs	<i>"The amount of AMH gives an indication of the number of eggs being produced, or ovarian reserve"</i>	19 (76%)
Predicts IVF response	<i>"An AMH is a measure of quantity and can infer how many eggs can be expected to develop in a fertility treatment cycle"</i>	9 (36%)
Assesses future fertility potential	<i>"You might want to consider an Anti-Mullerian hormone (AMH) test to get some insight into the remaining quantity of eggs and number of fertile years you may have left"</i>	9 (36%)
Assesses current fertility	<i>"AMH levels decline at predictable rates hence the AMH test is a good snapshot of current fertility"</i>	7 (28%)
Indicates polycystic ovary syndrome	<i>"A low AMH may indicate low egg reserve and high levels of AMH can be indicative of Polycystic Ovary Syndrome (PCOS)"</i>	6 (24%)
Predicts ovarian hyperstimulation syndrome (OHSS)	<i>"A high level may indicate an exaggerated response to the IVF medication"</i>	4 (16%)
Indicates increased risk of miscarriage	<i>"Women with diminished ovarian reserve have diminished fertility and increased risk of miscarriage"</i>	4 (16%)
Predicts time to menopause and indicates risk of early menopause	<i>"It may also identify women who may undergo early menopause, and therefore who may lose their fertility earlier than average"</i>	2 (8%)
Statements about who the AMH test is suitable for		
Women considering fertility treatment	<i>"The AMH test is useful if: You are considering IVF or other fertility medications, as low levels of AMH may indicate a potentially poor response to IVF and conversely a high level may indicate an exaggerated response to the IVF medication"</i>	12 (48%)
Women with risk factors for reduced fertility	<i>"Women who have had chemotherapy or ovarian/endometrial surgery and want to find out what effect it has had on their future fertility"</i>	9 (36%)
Women planning for pregnancy, now or in the future	<i>"If you are planning on having children one day, it's worth considering the egg timer test"</i>	8 (32%)
Women who have been trying to conceive for 6 months and are seeking reassurance	<i>"Women who have been trying to conceive for over 6 months, and are looking for reassurance that their ovarian reserve is appropriate for their age."</i>	6 (24%)
Women who want to check their ovarian reserve/ are curious	<i>"Women who would like to conceive in the future and are curious about their ovarian reserve"</i>	6 (24%)
Women considering delaying pregnancy	<i>"An AMH is often done to give reassurance to women who want to delay child-bearing"</i>	3 (12%)

	<i>"Your doctor may recommend an AMH test if you are wanting to delay childbirth and are under 35 years old"</i>	
Women undergoing IVF (to inform about dose change)	<i>"A low ovarian reserve result may indicate: if already undergoing fertility treatment, may call for a larger dose of fertility medication"</i>	1 (4%)
Women considering fertility preservation/ egg freezing	<i>"The expected success of the [egg freezing] procedure can be ascertained from an initial assessment of the ovarian reserve using a blood test for Anti-Mullerian Hormone (AMH) and an ultrasound scan of the ovaries and uterus"</i>	1 (4%)
Women over 35 years trying to conceive	<i>"If you are over 35 and haven't fallen pregnant within six months of trying, we may begin our assessment by checking your ovarian reserve"</i>	1 (4%)
Statements about possible actions in response to the result of the AMH test		
Informs when to access fertility treatment	<i>"This test provides a snapshot early on so a decision can be made on when to start trying for a baby and when to access fertility treatment."</i>	10 (40%)
Assists with reproductive life planning (when to start trying/if need to bring forward plans)	<i>"Once the ovaries run out of eggs, the body can't produce more. The last remaining eggs may not be great quality – so it's best to make an informed decision. The egg timer test can help with this"</i>	9 (36%)
Informs when to undertake elective egg freezing	<i>"It may however indicate the need for more proactive action such as beginning a family sooner or undertaking elective egg freezing"</i>	7 (28%)
Enables tailored IVF drug dose	<i>When fertility treatments are required, the AMH serves as a guide to the dosage of medications used"</i>	4 (16%)
Informs when to talk to a fertility specialist	<i>"A low AMH level is indicative of poor egg reserve, and you should then consider discussing your situation further with a fertility specialist"</i>	3 (12%)
Informs when to consider using donor eggs	<i>"What if my ovarian reserve is low?: if you've experienced premature menopause, we can talk about options including using donor eggs"</i>	3 (12%)
Stated caveats and limitations of the AMH test		
Quantity not quality	<i>"AMH indicates the quantity of eggs remaining in a woman's ovary and does not indicate the quality of the eggs in the ovary."</i>	9 (36%)
Cannot predict individual response/ does not predict chance of a live birth	<i>"A woman with a low AMH level will have the same chance of conceiving naturally"</i>	8 (32%)
Artificially lower or higher in certain women	<i>"AMH measurement is not 100% reliable and can be artificially lower in women who are very young, who are taking the contraceptive pill or who are very lean exercisers or those with pituitary problems."</i>	5 (20%)
Age is the most important factor of fertility	<i>"Please remember that age is still a very important factor for fertility."</i>	5 (20%)

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Lacks sensitivity, specificity/ imperfect test/ levels can fluctuate	<i>“It is impossible to entirely predict a woman’s chances of conception, so a normal result should always be considered cautiously in relation to future fertility”</i>	3 (12%)
Needs to be interpreted in conjunction with other factors/ needs specialist interpretation	<i>“The interpretation of the AMH result will depend on your medical history, your family’s fertility history, lifestyle and other investigations into your fertility”</i>	3 (12%)

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1) Statements about the utility of the AMH test

Eight specific statements about the utility of the test were identified, with 19 of the 25 websites listing at least one of these. The most common statement made about the usefulness of the test was that it is an indicator of ovarian reserve, or the number of eggs in the ovaries (76%; Table 1). Other recurring statements included that the test predicts IVF response (e.g. number of eggs collected; 36%), assesses women's future fertility potential (e.g. how many fertile years ahead; 36%) or determines women's current fertility status (28%).

2) Statements about who the test is suitable for

The test was recommended for a range of women in different circumstances and settings, including those undergoing assisted reproduction, women who were curious about their ovarian reserve and women who wanted to know their current and future fertility potential. The most common recommendations were for women considering fertility treatment (48%), women with risk factors for reduced fertility (e.g. family history of premature ovarian failure, women who have had chemotherapy, ovarian tumour, endometriosis; 36%) and for women planning pregnancy, now or in the future (32%).

3) Statements about possible actions in response to the result of the test

Several websites included statements about possible actions in response to the result of the test, with the most common being that the test results can inform women when to access fertility treatment (40%), assist with reproductive life planning (36%) and inform when to undertake elective egg freezing (28%).

4) Stated caveats and limitations of the AMH test

Some websites had statements reflecting caveats or limitations of the test. The most commonly stated limitations were that the test is an indicator of egg quantity not quality (36%), it does not predict chance of conceiving or having a live birth (32%), that age is still the most important factor for fertility (20%), and that the results can be artificially lower or higher in certain women, such as women who are heavy exercisers, are on the oral contraceptive pill, have PCOS or are very young (20%).

Additional observations

Some websites used persuasive language and assertions that actively promoted the test. The most common was adding a motivation or rationale for having the test (44%), such as stating "*Information is power and lets you take charge of your fertility*". Some also communicated the growing popularity and demand for the test (e.g. "*more and more women are seeking reassurance about their ability to reproduce*"; 8%) or emphasised the convenience of the test (e.g. "*a simple blood test*"; 44%).

There were also a number of contradictions in the information provided across the websites. These included contradicting statements about whether the AMH test can predict menopause, is an indicator of egg quality, whether the results need to be interpreted by a specialist or by a GP, and whether the test is accurate whilst using oral contraception. There was even conflicting information or confusing statements within the same website on three of the websites (12%), with the most common being whether or not the blood sample can be taken whilst using oral contraception and

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3 whether the test assesses women's fertility (e.g. "...not a measure of fertility but an important tool in
4 assessing potential fertility" and "an AMH test can assess your current fertility").
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7 DISCUSSION

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9 This study systematically recorded and categorised information about the AMH test found on
10 Australian and New Zealand fertility clinic websites. The information provided was highly variable
11 across the websites, from providing none or minimal information on the AMH test to providing
12 extensive information about the test. Some websites were found to be very transparent and upfront
13 regarding the test's limitations, whilst others did not mention limitations or included persuasive
14 statements actively promoting the test (e.g. promoting empowerment, proactive decision-making)
15 for a wide range of women in different circumstances. In addition, despite some websites containing
16 substantial information about the test, it was often disjointed and spread across several pages;
17 therefore comprehensive information may be difficult for women to find in one place. There were
18 also several confusing or unclear statements, as well as contradictions within and across websites.
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24 Importantly, whilst a number of statements about the utility of the test were made across a number
25 of websites, few are supported by high-level evidence. Statements for which there is supporting
26 evidence of benefit include the AMH test being an indicator of ovarian reserve and that it predicts
27 the number of eggs obtained in an IVF cycle.^{10 24} Statements with mixed evidence include low AMH
28 levels indicating increased risk of miscarriage.^{25 26} There is preliminary evidence that high levels of
29 AMH indicate PCOS,^{27 28} however more research is needed to confirm this and current PCOS
30 guidelines recommend against using AMH as a diagnostic tool.²⁹ Statements refuted by existing
31 evidence include the test being able to predict a woman's future fertility potential or current fertility
32 status,^{13-15 30} or identifying a woman at risk of early menopause.⁶ Whilst the AMH appears to be a
33 significant predictor of age at menopause at a population level, the imprecision in estimates and
34 limited capacity in predicting the extreme ages of menopause (e.g. it cannot identify those at risk of
35 early menopause) means its clinical applicability in individual women is limited.³¹ Considering this,
36 there were also several misleading corresponding statements about who the test is suitable for and
37 possible actions to be taken in response to the test result. This was particularly the case for websites
38 that recommended the test for women outside of fertility treatment settings (e.g. women planning
39 pregnancy now or in the future, women who are curious about their ovarian reserve) or websites
40 that claimed the test assisted with reproductive life planning (when to start trying to conceive) or
41 when to undertake elective egg freezing. So whilst the AMH test is an important component of
42 infertility assessment and can provide insight into the predicted ovarian response in ART, it should
43 not be used in women without a diagnosis of infertility.¹⁸
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51 Consequently, many websites include incorrect, overstated or misleading statements about the
52 ability of the AMH test to reliably predict fertility. This raises concerns that women who use the
53 AMH test to plan timing of pregnancy may get a false sense of security about delaying pregnancy if
54 their level is in the normal or high range, and give women with low readings unwarranted anxiety
55 about their ability to conceive. This could in turn potentially compel them to freeze their eggs,³² try
56 to conceive earlier than they had planned, or pursue fertility treatments when it may not be needed,
57 increasing the risk of overdiagnosis and overtreatment.³³ Whilst these findings may reflect the varied
58 views held about the utility of the AMH test and mixed evidence supporting its use in practice, it
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3 likely increases confusion for women seeking information regarding the AMH test and perpetuates
4 unrealistic expectations. Given fertility clinic websites have been found to be a primary source of
5 information for people seeking fertility treatments,³⁴ it is essential the information provided is
6 accurate and reflects the highest level of available evidence.²⁰
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10 Our findings of poor quality information on fertility clinic websites are similar to recent studies
11 evaluating the quality of website information regarding oocyte cryopreservation and of various
12 interventions used in addition to standard IVF procedures.^{20 35} For example, a recent analysis of the
13 quality of information about elective oocyte cryopreservation on Australian and New Zealand
14 fertility clinic websites found that more than half scored poor, indicating that women are not
15 receiving the information they need to make well informed choices.³⁵ To make autonomous
16 decisions, patients must be presented with accurate, balanced information regarding the risks,
17 benefits and limitations. Websites that do not state limitations or include misleading statements are
18 impeding consumer decision making and placing a large burden on clinicians to dispel
19 misconceptions.³⁶ The decision to have an AMH test may appear to be empowering, however this
20 rests on the false assumption that the test is an accurate predictor of fertility status.³⁶
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25 To our knowledge, this is the first study to rigorously and systematically assess publicly available
26 AMH-related information for women using the well-established content analysis method, which
27 involved a number of members of a multidisciplinary study team. The current study only included
28 blogs from 2015, so older posts were excluded. This decision was made as the quality of reporting on
29 the test before this time was poor and we felt it was not a fair judgement of the clinics' current
30 information. We also excluded non-text content, such as videos, which may have had more accurate
31 information. Website content also changes over time, so a different set of reviewers at a later date
32 might locate different information to what was captured. In addition, direct-to-consumer websites
33 or countries without accrediting bodies may have worse quality information, so replication in other
34 settings is warranted.
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39 In conclusion, some Australian and New Zealand fertility clinic websites contain a number of
40 statements regarding the utility of the AMH test which are not supported by the evidence and are
41 potentially misleading. Fertility clinics should provide information based on the best available
42 evidence and be transparent about uncertainties and limitations. In particular, the lack of utility of
43 the AMH test for women without a diagnosis of infertility needs to be much clearer to prevent
44 women having this test believing that it can accurately gauge their current and future fertility. These
45 are high stake decisions for women, so high quality, accurate information to enable informed
46 decision-making is essential.
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3 **Author contributions:** TC, KM and BN conceived the study. TC, BN, SL, KM and KH were involved in
4 designing the study and the data analysis. TC extracted the data from the websites and drafted the
5 manuscript. All authors contributed to the interpretation of the analysis, and critically revised and
6 approved the manuscript.
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12

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14 further competing interests exist.
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17 **Patient consent for publication:** Not required.
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20 **Ethics approval:** Ethics approval was not required as no human or animal subjects were used in the
21 experimental design, and the website information is freely available online.
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24 **Data availability statement:** No data are available.
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Anti-Mullerian hormone (AMH) test information on Australian and New Zealand fertility clinic websites: A content analysis

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3 **Anti-Mullerian hormone (AMH) test information on Australian and New Zealand fertility clinic**
4 **websites: A content analysis**
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8 Tessa Copp*^{1,2}, Brooke Nickel^{1,2}, Sarah Lensen³, Karin Hammarberg^{4,5}, Devora Lieberman⁶, Jenny
9 Doust⁷, Ben W. Mol⁸, Kirsten J. McCaffery^{1,2}
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12
13
14

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16 University of Sydney, 2006, Australia
- 17 2. Sydney Health Literacy Lab, Sydney School of Public Health, Faculty of Medicine and Health,
18 The University of Sydney, 2006, Australia
- 19 3. Obstetrics and Gynaecology, University of Melbourne, Melbourne, Australia, 3052
- 20 4. Victorian Assisted Reproductive Treatment Authority, 3000, Melbourne, Australia
- 21 5. School of Public Health and Preventive Medicine, Monash University, 3004, Melbourne,
22 Australia
- 23 6. City Fertility Centre, Sydney, Australia
- 24 7. Centre of Longitudinal and Life Course Research, School of Public Health, The University of
25 Queensland, Herston, 4006, Australia
- 26 8. Department of Obstetrics and Gynaecology, Monash University, Clayton, 3800, Australia
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34 *Corresponding author: Tessa Copp, Tessa.copp@sydney.edu.au
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Abstract

Objectives: The Anti-Mullerian hormone (AMH) test has been promoted as a way to inform women about their future fertility. However, data consistently shows the test is a poor predictor of natural fertility potential for an individual woman. As fertility centre websites are often a primary source of information for reproductive information, it is essential the information provided is accurate and reflects the available evidence. We aimed to systematically record and categorise information about the AMH test found on Australian and New Zealand fertility clinic websites.

Design: Content analysis of online written information about the AMH test on fertility clinic websites.

Setting: Accredited Australian and New Zealand fertility clinic websites

Methods: Data were extracted between April and June 2020. Any webpage that mentioned the AMH test, including blogs specifically about the AMH test posted since 2015, were analysed and the content categorised.

Results: Of the 39 active accredited fertility clinics' websites, 25 included information about the AMH test. The amount of information varied widely, and embodied four overarching categories; 1) the utility of the AMH test, 2) who the test is suitable for, 3) possible actions in response to the test, and 4) caveats and limitations of the test. Eight specific statements about the utility of the test were identified, many of which are not evidence-based. Whilst some websites were transparent regarding the test's limitations, others mentioned no caveats or included persuasive statements actively promoting the test as empowering for a range of women in different circumstances.

Conclusions: Several websites had statements about the utility of the AMH test that are not supported by the evidence. This highlights the need for higher standards for information provided on fertility clinic websites to prevent women being misled to believe the test can reliably predict their fertility.

Strengths and limitations of this study:

- First study to robustly and systematically assess publicly available AMH test information on fertility clinic websites
- Two researchers independently assessed all the extracted information about the AMH test, with any inconsistencies resolved with an additional member of the study team
- Only written content was assessed (e.g. videos were excluded), potentially missing relevant information on the AMH test
- Website content can change over time, meaning that different information may be identified if the study is repeated

INTRODUCTION

A woman's fertility declines with age, due to the reduction in the quality and quantity of her eggs over time.¹ In women, the anti-Mullerian hormone (AMH) is exclusively produced by granulosa cells of ovarian follicles during the early stages of their development.² AMH levels can be measured by a blood test, giving an indication of ovarian reserve, or the number of eggs remaining in the ovaries. In theory, higher levels of AMH indicate the presence of more eggs and higher fertility potential and low levels indicate that there are few eggs left and the woman is approaching menopause. Menopause typically occurs at approximately 50 years of age.³ However, loss of ovarian reserve is accelerated in approximately 10% of women leading to premature menopause and loss of fertility potential before the age of 40 years.⁴ The AMH test has been promoted as a way for women to find out how much longer they have to achieve pregnancy or how likely it is that pregnancy could be achieved at all,⁵ potentially encouraging proactive family planning and preventing childlessness caused by age-related infertility.⁶ Public interest in AMH testing is also increasing with the rise of elective egg freezing in women concerned about age-related fertility decline.^{7 8}

Whilst the AMH test may be valuable in assisted reproductive technology (ART) treatment management through indicating potential ovarian response and enabling personalised dose selection in stimulation protocols,^{9 10} it has limited predictability of live birth rates in both ART^{11 12} and spontaneous conception settings.¹³⁻¹⁵ In addition, whilst a low AMH level may reflect a quantitative decline in ovarian reserve, there is currently no consensus on the level which defines a depleted ovarian reserve. Indeed, pregnancy can still occur even at undetectable AMH levels, especially in young women.^{2 6 16} The AMH test is therefore not a reliable measure of fertility potential.¹³ It can also give false readings for women with polycystic ovary syndrome (PCOS) or who use oral contraceptives.¹⁷ The American College of Obstetricians and Gynaecologists recently released a statement against the use of AMH in women without a diagnosis of infertility as it is not supported by the evidence.¹⁸ Despite this, some fertility specialists and researchers¹⁹ have suggested that women in their late 20s have the test at regular intervals to monitor their fertility potential. In addition, online companies in countries such as the United States, Australia and the United Kingdom are now selling the test direct-to-consumers outside of clinical settings,⁷ offering women estimates of their fertility potential based on the results of the test. In Australia, AMH testing can occur in several ways, although women are predominantly referred by their GPs or fertility specialists to get the test from pathology laboratories or fertility clinics with in-house pathology. The test is not covered by Australia's universal health scheme and has out-of-pocket costs.

Fertility clinic websites along with social media are primary sources for women seeking reproductive information,²⁰ such as egg freezing.²¹ When "AMH test" or "egg timer test" are entered into the Google search engine, fertility clinic websites are among the first websites to appear. In Australia and New Zealand, fertility clinics must be accredited by the Reproductive Technology Accreditation Committee (RTAC).²² The RTAC Code of Practice states that clinics "...must provide patients with information that is accurate, timely, in formats and language appropriate to the patient...".²² Considering the popular narrative that the AMH test can predict fertility, the aim of this study was to systematically record and categorise any written information about the AMH test found on Australian and New Zealand fertility clinic websites.

METHOD

Setting

Accredited fertility clinics in Australia and New Zealand were identified from the list of accredited practices on the Fertility Society of Australia's website.²³ The websites of those clinics were accessed between April and June, 2020. All webpages that mentioned the AMH test, including posts or blogs specifically about the AMH test which had been posted since 2015 were scrutinised. Analysis was restricted to written context (i.e. videos and non-text data were excluded). Any webpages described as being specifically for clinicians (e.g. GPs) were also excluded. Websites that did not mention the AMH test were excluded from further analysis.

Study design

A content analysis of the information on fertility clinic websites about the AMH test was conducted. Content analysis is a widely used analysis method which combines qualitative and quantitative methods to analyse text data, allowing the content and frequency of categories to be reported.²⁴ Given the uncertain evidence about the utility of the AMH test, we aimed to systematically identify and categorise the statements made about the utility of the AMH test and related information. This method has previously been used to assess claims made on fertility clinic websites about the effectiveness of different treatments.²⁰ The study team included public health researchers (TC, BN, SL, KH, KM), a general practitioner and clinical epidemiologist (JD), a registered nurse (KH) and fertility specialists (BM, DL).

Patient and public involvement

No patients or public were involved. The data were derived from publicly available information on Australian and New Zealand fertility clinic websites.

Analysis

The analysis involved an iterative process with five members of the study team. After the number of eligible fertility clinic websites were ascertained and the data were extracted by one researcher (TC), content analysis was used to map out the areas of content that emerged and record and categorise the statements made about the AMH test, as well as additional observations. First, two researchers (TC and BN) independently reviewed information about the AMH test on 20 websites each to become familiar with the content and develop a list of recurring codes and themes. These codes and themes were discussed with a third researcher (SL) and informed an initial coding framework. All content was then coded independently by two researchers (TC and SL) into the framework to ensure rigour. Further revisions to the framework were discussed and made as required during coding. The level of agreement between the two coders was tested using Cohen's kappa and indicated a strong level of agreement ($\kappa=0.83$). Any inconsistencies in coding were then discussed and resolved, with a third researcher (BN) involved to come to a final agreement. Descriptive statistical analysis was used to calculate the frequency of each code, and quotes were chosen to illustrate findings.

RESULTS

Of the 41 accredited fertility clinics listed on the Fertility Society of Australia's website, two had merged with other fertility clinics, resulting in 39 eligible clinic websites. The number of web pages with content relating to the AMH test varied widely across websites from zero up to 12 pages (mean: 3.4 webpages per clinic website). Of the 39 eligible websites, 14 (36%) did not mention the

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3 AMH test at all and 8 (21%) only listed the test or gave a very brief description of the test, which did
4 not include any additional information such as potential benefits or limitations. The 14 websites that
5 did not mention the AMH test were excluded from further analysis (see Figure 1).
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10 Information about the AMH test on the remaining 25 clinic websites was organised into four
11 overarching categories; statements about 1) the utility of the AMH test, 2) who the test is suitable
12 for, 3) possible actions in response to the test, and 4) statements reflecting caveats and limitations
13 of the test. The overarching categories and their affiliated statements, quotes illustrating each
14 statement and proportions of clinic websites containing each statement are shown in Table 1. In
15 addition, two patterns of observations arose when analysing the data. These included the use of
16 persuasive language and contradictory information within and across websites.
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Table 1. Statements about the AMH test on fertility clinic websites (N=25 websites)

Categories and codes	Example quote	n (%)
Statements about the utility of the AMH test		
Indicator of ovarian reserve/number of eggs	<i>"The amount of AMH gives an indication of the number of eggs being produced, or ovarian reserve"</i>	19 (76%)
Indicates response to fertility treatment (i.e. number of eggs collected, treatment/IVF success)	<i>"An AMH is a measure of quantity and can infer how many eggs can be expected to develop in a fertility treatment cycle" "It can also help a fertility specialist determine whether a woman is a good candidate to undergo certain fertility treatments and how successful those treatments may be"</i>	9 (36%)
Assesses future fertility potential	<i>"You might want to consider an Anti-Mullerian hormone (AMH) test to get some insight into the remaining quantity of eggs and number of fertile years you may have left"</i>	9 (36%)
Assesses current fertility	<i>"AMH levels decline at predictable rates hence the AMH test is a good snapshot of current fertility"</i>	7 (28%)
Indicates polycystic ovary syndrome	<i>"A low AMH may indicate low egg reserve and high levels of AMH can be indicative of Polycystic Ovary Syndrome (PCOS)"</i>	6 (24%)
Predicts ovarian hyperstimulation syndrome (OHSS)	<i>"A high level may indicate an exaggerated response to the IVF medication"</i>	4 (16%)
Indicates increased risk of miscarriage	<i>"Women with diminished ovarian reserve have diminished fertility and increased risk of miscarriage"</i>	4 (16%)
Predicts time to menopause and indicates risk of early menopause	<i>"It may also identify women who may undergo early menopause, and therefore who may lose their fertility earlier than average"</i>	2 (8%)
Statements about who the AMH test is suitable for		
Women considering fertility treatment	<i>"The AMH test is useful if: You are considering IVF or other fertility medications, as low levels of AMH may indicate a potentially poor response to IVF and conversely a high level may indicate an exaggerated response to the IVF medication"</i>	12 (48%)
Women with risk factors for reduced fertility	<i>"Women who have had chemotherapy or ovarian/endometrial surgery and want to find out what effect it has had on their future fertility"</i>	9 (36%)
Women planning for pregnancy, now or in the future	<i>"If you are planning on having children one day, it's worth considering the egg timer test"</i>	8 (32%)
Women who have been trying to conceive for 6 months and are seeking reassurance	<i>"Women who have been trying to conceive for over 6 months, and are looking for reassurance that their ovarian reserve is appropriate for their age."</i>	6 (24%)

Women who want to check their ovarian reserve/ are curious	<i>"Women who would like to conceive in the future and are curious about their ovarian reserve"</i>	6 (24%)
Women considering delaying pregnancy	<i>"An AMH is often done to give reassurance to women who want to delay child-bearing" "Your doctor may recommend an AMH test if you are wanting to delay childbirth and are under 35 years old"</i>	3 (12%)
Women undergoing IVF (to inform about dose change)	<i>"A low ovarian reserve result may indicate: if already undergoing fertility treatment, may call for a larger dose of fertility medication"</i>	1 (4%)
Women considering fertility preservation/ egg freezing	<i>"The expected success of the [egg freezing] procedure can be ascertained from an initial assessment of the ovarian reserve using a blood test for Anti-Mullerian Hormone (AMH) and an ultrasound scan of the ovaries and uterus"</i>	1 (4%)
Women over 35 years trying to conceive	<i>"If you are over 35 and haven't fallen pregnant within six months of trying, we may begin our assessment by checking your ovarian reserve"</i>	1 (4%)
Statements about possible actions in response to the result of the AMH test		
Informs when to access fertility treatment	<i>"This test provides a snapshot early on so a decision can be made on when to start trying for a baby and when to access fertility treatment."</i>	10 (40%)
Assists with reproductive life planning (when to start trying/if need to bring forward plans)	<i>"Once the ovaries run out of eggs, the body can't produce more. The last remaining eggs may not be great quality – so it's best to make an informed decision. The egg timer test can help with this"</i>	9 (36%)
Informs when to undertake elective egg freezing	<i>"It may however indicate the need for more proactive action such as beginning a family sooner or undertaking elective egg freezing"</i>	7 (28%)
Enables tailored IVF drug dose	<i>When fertility treatments are required, the AMH serves as a guide to the dosage of medications used"</i>	4 (16%)
Informs when to talk to a fertility specialist	<i>"A low AMH level is indicative of poor egg reserve, and you should then consider discussing your situation further with a fertility specialist"</i>	3 (12%)
Informs when to consider using donor eggs	<i>"What if my ovarian reserve is low?: if you've experienced premature menopause, we can talk about options including using donor eggs"</i>	3 (12%)
Stated caveats and limitations of the AMH test		
Quantity not quality	<i>"AMH indicates the quantity of eggs remaining in a woman's ovary and does not indicate the quality of the eggs in the ovary."</i>	9 (36%)
Cannot predict individual response/ does not predict chance of a live birth	<i>"A woman with a low AMH level will have the same chance of conceiving naturally"</i>	8 (32%)

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Artificially lower or higher in certain women	<i>"AMH measurement is not 100% reliable and can be artificially lower in women who are very young, who are taking the contraceptive pill or who are very lean exercisers or those with pituitary problems."</i>	5 (20%)
Age is the most important factor of fertility	<i>"Please remember that age is still a very important factor for fertility."</i>	5 (20%)
Lacks sensitivity, specificity/ imperfect test/ levels can fluctuate	<i>"It is impossible to entirely predict a woman's chances of conception, so a normal result should always be considered cautiously in relation to future fertility"</i>	3 (12%)
Needs to be interpreted in conjunction with other factors/ needs specialist interpretation	<i>"The interpretation of the AMH result will depend on your medical history, your family's fertility history, lifestyle and other investigations into your fertility"</i>	3 (12%)

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1) Statements about the utility of the AMH test

Eight specific statements about the utility of the test were identified, with 19 of the 25 websites listing at least one of these. The most common statement made about the usefulness of the test was that it is an indicator of ovarian reserve, or the number of eggs in the ovaries (76%; Table 1). Other recurring statements included that the test indicates response to fertility treatment (e.g. number of eggs collected (n=6) or vague treatment success statements (n=3) e.g. "...a good predictor of IVF success"; 36%), assesses women's future fertility potential (e.g. how many fertile years ahead; 36%) or determines women's current fertility status (28%).

2) Statements about who the test is suitable for

The test was recommended for a range of women in different circumstances and settings, including those undergoing assisted reproduction, women who were curious about their ovarian reserve and women who wanted to know their current and future fertility potential. The most common recommendations were for women considering fertility treatment (48%), women with risk factors for reduced fertility (e.g. family history of premature ovarian failure, women who have had chemotherapy, ovarian tumour, endometriosis; 36%) and for women planning pregnancy, now or in the future (32%).

3) Statements about possible actions in response to the result of the test

Several websites included statements about possible actions in response to the result of the test, with the most common being that the test results can inform women when to access fertility treatment (40%), assist with reproductive life planning (36%) and inform when to undertake elective egg freezing (28%).

4) Stated caveats and limitations of the AMH test

Some websites had statements reflecting caveats or limitations of the test. The most commonly stated limitations were that the test is an indicator of egg quantity not quality (36%), it does not predict chance of conceiving or having a live birth (32%), that age is still the most important factor for fertility (20%), and that the results can be artificially lower or higher in certain women, such as women who are heavy exercisers, are on the oral contraceptive pill, have PCOS or are very young (20%).

Additional observations

Use of persuasive language

Some websites used persuasive language and assertions that actively promoted the test. The most common was adding a motivation or rationale for having the test (44%), such as stating "*Information is power and lets you take charge of your fertility*". Some also communicated the growing popularity and demand for the test (e.g. "*more and more women are seeking reassurance about their ability to reproduce*"; 8%) or emphasised the convenience of the test (e.g. "*a simple blood test*"; 44%).

Confusing statements and contradictions

There were also a number of contradictions in the information provided across the websites. These included contradicting statements about whether the AMH test can (n=2) or cannot predict menopause (n=1), is an indicator (n=1) or is not an indicator of egg quality (n=9), whether the results need to be interpreted by a specialist (n=2) or by a GP (n=3), and whether the test is reliable (n=6) or

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3 can be artificially lower when using oral contraception (n=5). There was even conflicting, ambiguous
4 and confusing statements within the same website on three of the websites (12%), with the most
5 common being whether or not the blood sample can be taken whilst using oral contraception and
6 whether the test assesses women's fertility (e.g. "*...not a measure of fertility but an important tool in*
7 *assessing potential fertility*" and then in the next paragraph "*an AMH test can assess your current*
8 *fertility*").
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11 12 DISCUSSION 13

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15 This study systematically recorded and categorised information about the AMH test found on
16 Australian and New Zealand fertility clinic websites. The information provided was highly variable
17 across the websites, from providing none or minimal information on the AMH test to providing
18 extensive information about the test. Some websites were found to be very transparent and upfront
19 regarding the test's limitations, whilst others did not mention limitations or included persuasive
20 statements actively promoting the test (e.g. promoting empowerment, proactive decision-making)
21 for a wide range of women in different circumstances. In addition, despite some websites containing
22 substantial information about the test, it was often disjointed and spread across several pages;
23 therefore comprehensive information may be difficult for women to find in one place. There were
24 also several confusing or unclear statements, as well as contradictions within and across websites.
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30 Importantly, whilst a number of statements about the utility of the test were made across a number
31 of websites, few are supported by high-level evidence. Statements for which there is some
32 supporting evidence include the AMH test being an indicator of ovarian reserve^{10 25} in terms of egg
33 quantity and it being associated with the number of eggs obtained in an IVF cycle,^{9 26 27} although
34 large variation in ovarian response remains unexplained.²⁷ Statements with mixed evidence include
35 low AMH levels indicating increased risk of miscarriage.^{28 29} There is preliminary evidence that high
36 levels of AMH indicate PCOS,^{30 31} however more research is needed to confirm this and current PCOS
37 guidelines recommend against using AMH as a diagnostic tool.³² Statements refuted by existing
38 evidence include the test being able to predict a woman's future fertility potential or current fertility
39 status,^{13-15 33} or identifying a woman at risk of early menopause.⁶ Furthermore, it is important to
40 note that although the AMH may be associated with outcomes at a population level, this does not
41 mean it has predictive value for individuals. For example, whilst the AMH appears to be associated
42 with age of menopause at a population level, the huge individual variation, imprecision in estimates
43 and limited capacity in predicting the extreme ages of menopause (e.g. it cannot identify those at
44 risk of early menopause) means its clinical applicability in individual women is limited.³⁴ Questions
45 have also been raised about whether AMH adds substantive predictive value over and above readily
46 available patient characteristics, such as age.^{9 35} Considering this, there were also several misleading
47 corresponding statements about who the test is suitable for and possible actions to be taken in
48 response to the test result. This was particularly the case for websites that recommended the test
49 for women outside of fertility treatment settings¹⁸ (e.g. women planning pregnancy now or in the
50 future, women who are curious about their ovarian reserve) or websites that claimed the test
51 assisted with reproductive life planning (when to start trying to conceive) or when to undertake
52 elective egg freezing.
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Consequently, many websites include incorrect, overstated or misleading statements about the ability of the AMH test to reliably predict fertility. This raises concerns that women who use the AMH test to plan timing of pregnancy may get a false sense of security about delaying pregnancy if their level is in the normal or high range, and give women with low readings unwarranted anxiety about their ability to conceive. This could in turn increase women's perceived need to freeze their eggs,³⁶ try to conceive earlier than they had planned, or pursue fertility treatments when it may not be needed, increasing the risk of healthy individuals receiving unnecessary fertility care.³⁷ Whilst many clinics do not receive direct financial benefit from ordering the test, clinics would benefit from the outlined potential actions as a result of women getting the test result, such as seeing a fertility specialist, egg freezing or commencing fertility treatment. Although these findings may reflect the varied views held about the utility of the AMH test and mixed evidence supporting its use in practice, it likely increases confusion for women seeking information regarding the AMH test and perpetuates unrealistic expectations. Given fertility clinic websites have been found to be a primary source of information for people seeking fertility treatments,³⁸ it is essential the information provided is accurate and reflects the highest level of available evidence.²⁰

Our findings of misleading or inaccurate information on fertility clinic websites are similar to recent studies evaluating the quality of website information regarding oocyte cryopreservation and of various interventions used in addition to standard IVF procedures.^{20 39} For example, a recent analysis of the quality of information about elective oocyte cryopreservation on Australian and New Zealand fertility clinic websites found that more than half scored poor, indicating that women are not receiving the information they need to make well informed choices.³⁹ To make autonomous decisions, patients must be presented with accurate, balanced information regarding the risks, benefits and limitations. Websites that do not state limitations or include misleading statements are impeding consumer decision making and placing a large burden on clinicians to dispel misconceptions.⁴⁰ The decision to have an AMH test may appear to be empowering, however this rests on the false assumption that the test is an accurate predictor of fertility status.⁴⁰

To our knowledge, this is the first study to rigorously and systematically assess publicly available AMH-related information for women using the well-established content analysis method, which involved a number of members of a multidisciplinary study team. The current study only included blogs from 2015, so older posts were excluded. This decision was made as the quality of reporting on the test before this time was poor and we felt it was not a fair judgement of the clinics' current information. A limitation of the study is that it is unclear how consumers would interpret the information. Future studies are needed to assess how women interpret and respond to the information captured. We also excluded non-text content, such as videos, which may have had more accurate information. Website content also changes over time, so a different set of reviewers at a later date might locate different information to what was captured. In addition, direct-to-consumer websites or fertility clinics in countries without accrediting bodies may have worse quality information, so replication in other settings is warranted.

In conclusion, some Australian and New Zealand fertility clinic websites contain a number of statements regarding the utility of the AMH test which are not supported by the evidence and are potentially misleading. Fertility clinics should provide information based on the best available evidence and be transparent about uncertainties and limitations. In particular, the lack of utility of

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3 the AMH test for women without a diagnosis of infertility needs to be much clearer to prevent
4 women having this test believing that it can accurately gauge their current and future fertility. These
5 are high stake decisions for women, so high quality, accurate information to enable informed
6 decision-making is essential.
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13 **Author contributions:** TC, KM and BN conceived the study. TC, BN, SL, KM and KH were involved in
14 designing the study and the data analysis. TC extracted the data from the websites and drafted the
15 manuscript. TC, BN, SL, KH, DL, JD, BWM and KM contributed to the interpretation of the analysis,
16 and critically revised and approved the manuscript.
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23 **Competing interests:** BWM reports consultancy for ObsEva, Merck, Merck KGaA and Guerbet. No
24 further competing interests exist.
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27 **Patient consent for publication:** Not required.
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30 **Ethics approval:** Ethics approval was not required as no human or animal subjects were used in the
31 experimental design, and the website information is freely available online.
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34 **Data availability statement:** No data are available. The data were derived from publicly available
35 information on Australian and New Zealand fertility clinic websites.
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14 **Figure legend:**

15 Figure 1. Flow diagram of accredited fertility clinic websites included in the current study.
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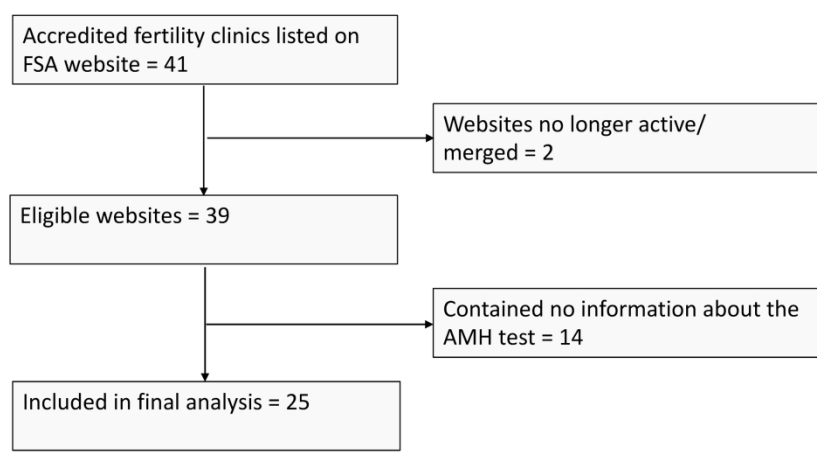


Figure 1. Flow diagram of accredited fertility clinic websites included in the current study.

261x149mm (300 x 300 DPI)