

Expert System for Diagnosing Gingivitis Using the Certainty Factor Method

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Abstract

Gingivitis is one of the oral health disorders caused by inflammation of the gum tissue. This disease is often considered mild, but if it is not treated promptly, it can develop into a more serious condition. The lack of public knowledge regarding the early symptoms of gingivitis, along with limited access to dentists and the relatively high cost of dental examinations, causes many sufferers to be late in recognizing their oral health condition. Therefore, an expert system is needed to assist in the early diagnosis of gingivitis quickly and easily using the Certainty Factor method. Based on the analysis and Certainty Factor calculations conducted according to the selected symptoms, the diagnosis result obtained was Acute Gingivitis with a confidence level of 98.98%.

Keywords: Expert System, Gingivitis, Certainty Factor

1. Introduction

Oral health is an essential part of overall health. One of the most common oral health problems is gingivitis, an inflammation of the gums that is often considered a minor condition but can develop into a more serious disease if left untreated. Limited public awareness of the early symptoms of gingivitis frequently results in delayed detection and treatment.

In clinical practice, gingivitis is generally diagnosed by dentists through the observation of symptoms such as gum swelling, redness, bleeding during tooth brushing, and bad breath. However, factors such as differences in professional experience, limited consultation time, examination costs, and restricted access to dental healthcare services may hinder early diagnosis. Therefore, a system that can assist in providing a fast and accurate preliminary diagnosis of gingivitis is needed.

An expert system is a computer program designed to emulate the knowledge and expertise of a human specialist in a particular domain. Through this system, computers can assist humans in making decisions and solving problems in a manner similar to that of an expert [1]. An expert system can function as an assistant that supports the work of specialists. It operates by integrating reasoning rules with a knowledge base acquired from one or more experts in a specific field, enabling the system to provide solutions or recommendations that reflect expert-level knowledge and expertise[2].

2. Research Methods

The Certainty Factor (CF) method is an approach used to represent the level of confidence in a particular piece of information or rule. CF values are expressed numerically and indicate the degree of certainty associated with a conclusion [3]. The confidence level of a conclusion may increase or decrease depending on the available evidence. An increase in confidence is represented by the Measure of Belief (MB), while a decrease in confidence is represented by the Measure of Disbelief (MD) [2].

The Certainty Factor (CF) method involves several calculation stages, as follows:

1. Identifying and preparing the symptom and disease data to be used in the system.
2. Constructing IF-THEN rules based on the relationships between symptoms and diseases.

An example of the rule structure used in the system is as follows:

IF Symptom 1
AND Symptom 2
AND Symptom 3
THEN Disease

3. Determining the confidence values assigned by both the expert and the user for each symptom.
4. Calculating the Certainty Factor value using the following equations:
 $CF(H,E) = CF(\text{expert}) \times CF(\text{user})$ [4]
 For multiple symptoms, the certainty values are combined using the following formula:
 $CF_{\text{combine}}(H) = CF(H,E)_{\text{old}} + CF(H,E)_{\text{new}} \times [1 - CF(H,E)_{\text{old}}]$ [4]
 $CF_{\text{combine}} = CF(R1) + [CF(R2) \times (1 - CF(R1))]$
 The confidence percentage is calculated as:
 $\text{Confidence Percentage} = CF \times 100\%$
 Where:
 a) $CF(H,E)$ represents the certainty value of a hypothesis (H) influenced by evidence or symptoms (E).
 b) $CF(R1)$ represents the certainty value obtained from the first symptom calculation.
 c) $CF(R2)$ represents the certainty value obtained from the second symptom calculation.
5. The calculated Certainty Factor values are then combined to obtain the final diagnostic result, which is expressed as a percentage representing the system's confidence level in the diagnosis.

Table 1: Symptoms of Gingivitis

Symptom Id	Sympton	Jenis Penyakit			
		Acute Gingivitis	Subacute Gingivitis	Recurrent Gingivitis	Chronic Gingivitis
G01	Gums that bleed easily	Yes	Yes	Yes	Yes
G02	Sudden tooth pain without stimulation	Yes	–	–	–
G03	Severe gum swelling	Yes	Yes	–	Yes
G04	Presence of periodontal pockets	Yes	–	–	Yes
G05	Persistent bad breath	Yes	Yes	–	Yes
G06	Bleeding during examination	Yes	–	–	Yes
G07	Dark red discoloration of the gums	Yes	Yes	Yes	Yes
G08	Softened gum tissue with potential tooth mobility	Yes	Yes	–	Yes
G09	Gum discoloration turning pale to dark	–	Yes	–	–
G10	Intermittent pain	Yes	Yes	–	–
G11	Mild swelling that may subside	Yes	Yes	–	–
G12	Presence of a small number of periodontal pockets	–	–	Yes	–
G13	Mild bleeding during examination	–	–	Yes	–
G14	Rounded gum appearance (loss of stippling)	–	–	Yes	–
G15	Gum recession	–	–	–	Yes
G16	Increased spacing between teeth	–	–	Yes	Yes
G17	Gum pain upon touch	Yes	Yes	Yes	Yes
G18	Presence of pus between the gums and teeth	–	–	–	Yes
G19	Changes in tooth position during biting	–	–	–	Yes

Table 2 : Certainty Factor Scale

Certainty Term	CF Value
Not Present	0
Very Uncertain	0,2
Less Certain	0,4
Moderately Certain	0,6
Certain	0,8
Very Certain	1

Table 3 : Expert and User Confidence Value

Number	Symptom	Disease Type	Expert CF Value	User CF Value
1	Gums that bleed easily	Acute Gingivitis	1	0,8
2	Severe gum swelling		0,8	0,6
3	Bleeding during examination		1	0,6
4	Dark red discoloration of the gums		0,8	0,8
5	Gum pain upon touch		0,8	0,4
6	Gums that bleed easily	Subacute Gingivitis	0,4	0,8
7	Severe gum swelling		0,4	0,6
8	Bleeding during examination		0	0,6
9	Dark red discoloration of the gums		0,6	0,8
10	Gum pain upon touch		0,4	0,4
11	Gums that bleed easily	Recurrent Gingivitis	0,6	0,8
12	Severe gum swelling		0	0,6
13	Bleeding during examination		0	0,6
14	Dark red discoloration of the gums		0,8	0,8

Number	Symptom	Disease Type	Expert CF Value	User CF Value
15	Gum pain upon touch	Chronic Gingivitis	0,6	0,4
16	Gums that bleed easily		0,6	0,8
17	Severe gum swelling		0,6	0,6
18	Bleeding during examination		0,8	0,6
19	Dark red discoloration of the gums		0,6	0,8
20	Gum pain upon touch		0,6	0,4

Table 4 : Symptom Certainty Factor Value

Number	Symptom CF Result
1	0,80
2	0,48
3	0,60
4	0,64
5	0,32
6	0,32
7	0,24
8	0
9	0,48
10	0,16
11	0,48
12	0
13	0
14	0,64
15	0,24
16	0,48
17	0,36
18	0,48
19	0,48
20	0,24

Table 5 : Combined Certainty Factor Value

Number	Disease Type	Combined CF Result
1	Acute Gingivitis	0,80
2		0,896
3		0,9584
4		0,9850
5		0,9898
6	Subacute Gingivitis	0,32
7		0,4832
8		0,4832
9		0,7312
10	Recurrent Gingivitis	0,7743
11		0,48
12		0,48
13		0,48
14	Chronic Gingivitis	0,8128
15		0,8577
16		0,48
17		0,6672
18		0,8269
19		0,9100
20		0,9316

The final confidence percentage is calculated as:

Confidence Percentage = $CF \times 100\%$ Based on the results of the Certainty Factor calculation, the diagnostic results obtained are presented in the following table.

Tabel 6: Final Results

Acute Gingivitis	98,98%
Subacute Gingivitis	77,43%
Recurrent Gingivitis	85,77%
Chronic Gingivitis	93,16%

3. Results and Discussion

The expert system for diagnosing gingivitis was developed using PHP as the programming language for building the system, while MySQL was utilized as the database management system for storing and managing the application data.

1. Home Page

This page is used by users to access information about the system and initiate the Gingivitis disease diagnosis consultation process.

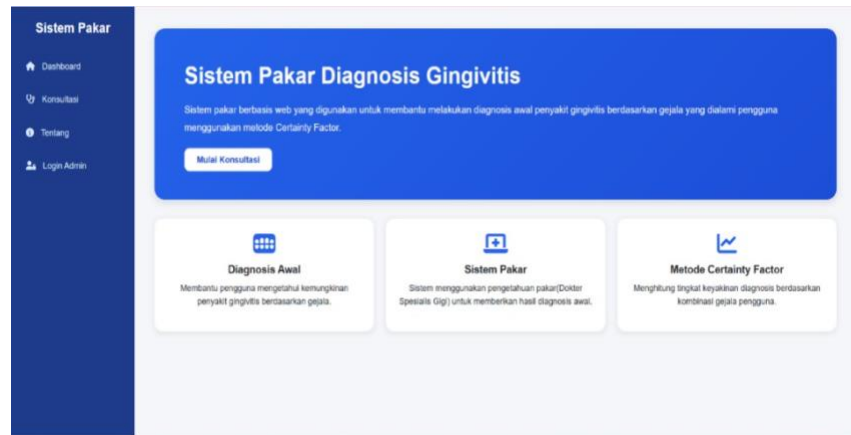


Fig. 1: Home Page

2. Consultation Page

This page displays all symptoms of gingivitis that can be selected by users according to the symptoms they are experiencing.

Form Konsultasi

Nama Pasien:

Umur:

Jenis Kelamin:

Pilih Gejala yang Dialami:

Gusi mudah berdarah

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Nyeri bila-bila pada gigi saat disentuh

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Pembengkakan gusi yang cukup parah

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Adanya bau gusi

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Bau mulut tidak sedap

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Pendarahan saat diperiksa (skor 1-3)

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Perubahan warna gusi menjadi kemerahan pekat

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Jaringan gusi lunak dan berpotensi gonyang

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Warna gusi berubah menjadi pucat kehitaman

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Nyeri hilang timbul

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Pembengkakan ringan yang dapat mereda

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Sakit gusi dalam jumlah sedikit

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Pendarahan ringan saat pemeriksaan (skor 0-1)

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Berubah gusi agak membesar (swelling)

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Pengerasan gusi

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Jarak antar gigi terasa renggang

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Nyeri pada gusi saat disentuh

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Terdapat nanah antara gusi dan gigi

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Perubahan posisi gigi saat menggigit

☒ Tidak ☐ Sedikit Ya ☐ Kurang Ya ☐ Cukup Ya ☐ Ya ☐ Sangat Ya

Fig.2 : Consultation Page

3. Results Page

This page displays the consultation results generated based on the gingivitis symptoms selected by the user.

Hasil Diagnosa

Gingivitis Akut

Persentase Keyakinan : 99.99%

Tingkat Keparahan : Kritis

Deskripsi

Gingivitis akut merupakan peradangan pada gusi yang terjadi secara cepat dan biasanya disertai gejala yang cukup jelas seperti gusi mudah berdarah, nyeri bila-bila pada gigi, pembengkakan gusi yang parah, dan bau mulut tidak sedap.

Solusi

Swelling, pemberian antibiotik, antiseptik, dan pemeriksaan ke dokter gigi.

Rekomendasi Tindakan

Menyikat gigi secara rutin, menjaga kebersihan rongga mulut, membersihkan gigi setelah makan, dan segera memeriksakan diri ke dokter gigi jika pembengkakan tidak mereda.

Segera lakukan pemeriksaan ke dokter gigi untuk penanganan lebih lanjut.

Ranking Kemungkinan Penyakit

Ranking	Penyakit	Nilai CF	Persentase
1	Gingivitis Akut	0.9998	99.98%
2	Gingivitis Kronis	0.9316	93.16%
3	Gingivitis Rekuren	0.8577	85.77%
4	Gingivitis Sub Akut	0.7743	77.43%

Detail Perhitungan Certainty Factor

Kode Gejala	Gejala	CF User	CF Pakar	CF Hasil
G01	Gusi mudah berdarah	0.8	1	0.8
G03	Pembengkakan gusi yang cukup parah	0.6	0.8	0.48
G06	Pendarahan saat diperiksa (skor 1-3)	0.6	1	0.6
G07	Perubahan warna gusi menjadi kemerahan pekat	0.8	0.8	0.64
G17	Nyeri pada gusi saat disentuh	0.4	0.8	0.32

Fig. 3 : Results Page

4. Conclusion

Based on the results of the study, the gingivitis diagnosis expert system using the Certainty Factor method can assist users in identifying the type of gingivitis based on the symptoms experienced. The system provides diagnostic results along with their confidence levels, making it useful as an initial source of information before consulting a dentist. The testing results showed that the highest confidence value was obtained for Acute Gingivitis, with a confidence level of 98.98%.

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